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A

Acanthurus heloides, 47
caerulius, 47
Accessions, 104
Aequidens latifrons, 9, 19
Ailuraedus maculosus, 59
Albright, Horace M., 186
Aldrovandi, 80
Alpine sun lamp, 49
Amblyornis inornatus, 55
Ameiurus nebulosus, 129
Animal associations, 71
Anteres, yacht, 178
Antilocapra americana, 195
Americana mexicana, 184
Aps, anthropoid, records, 196
Apogonichthys strombi, 72
Aquarium, A new department, 3
exhibition tanks, 3
experimental work room, 8
Aquarium fishes, World-wide interest in, 13
Astor, Vincent, 107, 139

B

Bailey, L. V., 186
Barbs, 8
rosy, 8
Day's, 8
Barbus comchonius, 8
vittatus, 8
Barker, Elliott S., 186
Barrett, Charles, 55, 66
Bartlett, C. A., 205
Barton, Otis, 38, 143
Barracuda, 133
Bathysphaera intacta, 177
Bathysphere, half-mile dive, 143
broadcast, 173
Beau gregory, breeding of, 121
Beckwith, Traffic Officer, 207
Beebe, William, 35, 41, 73, 139, 143, 175, 177
gift to Society, 42
Bell, W. B., 186
Bermudichthys subfurcatus, 43
Betta splendens, 9
Biological Station for Research, 41
Birds of paradise, new, 96
Blair, W. Reid, 35
Bower-birds and their bower, 55
Bower-bird, cat bird, 59
fawn-breasted, 65
golden, 55
New Guinea's Gardiner, 55
Regent, 57
Satin, 55, 66, 68
spotted, 62
tooth-billed, 57
yellow-spotted, 63
Brachydanio rerio, 8, 12
spawning, 22
Brassey, Lady Ann, 81
Breder, Jr., C. M., 3, 31, 85, 129
Broadbent, Kendall, 57
Bullheads, breeding of, 129
Burgess, General Harry, 215
Bushmaster, In quest of the, 213

C

Campbell, A. G., 58
Canfield, C. A., 205
Carter, T. Donald, 96
Chaffer, Norman, 62
Chance, Edwin M., 142
Chisholm, Alec H., 57
Chlamydera maculata, 62
cerviniventris, 65
guttata, 63
nuchalis, 63
Cichlids, broad-headed, 9, 19
spawning, 22
Coates, C. W., 10, 17
Cobilidae (family), 8
Cobitis fossilis, 8
Color changes in Blue-head wrasse, 43
Commensalism, 73
Conklin, E. G., 41
Conklin, Edwin G., 142
Contour shore-diving, 177
method evolved, 177
observations, 177
visibility, 177
Cook, W. B., 186
Copeina arnoldi, 22
Cornell University, 17
Couches platy, 9
Concha, 72
Crandall, Lee S., 55, 65, 96, 207
Crane, Jocelyn, 39, 142, 146
Cyprinodontidae (family), 8

D

Damon, Mrs. William Emerson, 10
fund, 10
Dana, Marshall N., 186
Danio, malabar, 8, 17
malabaricus, 8
spawning, 22
zebra, 8
de Coronado, Francisco Vasquez, 183
Deep-sea collecting, 139
Deep-sea fish, new, 175
De Sola, C. Ralph, 75
Development, tropical aquarium fishes, 15
Ditmars, Raymond L., 96, 213
Dive in Bathysphere, A half-mile, 143
contour shore-diving, 177
diving experiences, 145
Dollo's tilapia, 9
Dovekie invasion, 207
breeding range of, 208
flocks observed, 211
food of, 211
weight, 212
Drescher, William F., 209
Dunton, S. C., 107

E

Echensis naucratis, 85
remora, 81
Echiostoma etenobarba, 49
Educational activities, 139
work, 103
Eels, silver lamprey, 75
Egyptian mouth breeder, 9
Electric fishes, 131
eels, 131
Epibdella melleni, 123, 125
Eretmochelys imbricata, 83
Essenberg, 15

F

Family life of certain small fishes, 17
Fish parasite, destructive, Life history and control, 123
Fishes from Pacific coral reefs, 107
Fishing with fisherman fish in West Indies, 75
remora fishing in West Indies, 76
historical summary, 77
location of Queen's Gardens, 79
remora fishing to-day, 81
experimental evidence, 84
conclusions, 85
acknowledgments, 85
Fitzgerald, Admiral, 178
Floor-pool dwellers, 133
Flying squids, 177
Franz, Edith H., 104
Freeman, Ross, 93

G

Gaff-topsail catfish, 129
Galapagos tortoise, nest of, 93
tortoises in Bermuda, 121
Gambusia, Texas, 8
affinis, 8
Gesner, Konrad, 80
Gorilla, growth of, 93
growth chart, 139
Gordon, Myron, 10
Gouramies, 9
Grant, Madison, 42, 134
Greenhall, Arthur, 219
Gudger, E. W., 71, 77, 80, 85
Guppy, 9

H

Halliday, Abe, 219
Handbook of Shore Fishes of Bermuda, 35, 37
Hanover Chemical Company, 49
Haplochromis strigigena, 9
Hardin, J. B., 186
Hemichromis bimaculalus, 9, 19
Heredity, examples in, 17
Heterandria formosa, 8
Hindwood, K. A., 62
Holbrook, A portrait of, 137
Holder, Charles Frederick, 80
Hollister, Gloria Elaine, 35, 38, 49, 143, 146, 173, 178
Holmwood, Frederick, 76
Hyla, 215

I

Imperial and International Communication Co., 173
Inquilinism, 72
Interesting arrivals, 93
reptiles,
Irido meyeri, 47
garnote, 47
Items of interest, 93

J

Jardinellas de la Reina, 79, 83
Jewel fish, 19
Johnson, O. H., 186

K

"Kamongo", The Lung Fish, 134
Killer whale, An early account of, 134
Killie, one-spotted, 9
Killiefishes, 8
Kuhn, R. L., 127

L

Lachesis muta, 213
Lanternfish, 41
Lantern slides, 103
Lebistes reticulatus, 9, 13, 14
Legendre, Mr. & Mrs. Sydney J., 96
gift of, 96
Indo-China expedition, 96
Leister, Claude W., 103, 139, 183
Leptodactylus, 215
Le Souef, Dudley, 66
Library, The, 103
purchases, 103
gifts, 103
Limia, blackbanded, 9
nigrofasciata, 9
Litsea dealbata, 59
Loaches, 8
common, 8
Lung fish, 134

M

Mac Callum, G. A., 123
Macropodus opercularis, 9, 15
chinensis, 9
Mapepire Z'Ananna, 195
Marine fishes, exchanging, 139
Mason, Charles, 84
McMurtery, M. S., 186
Medaka, 13
Mexican platyfish, 14
Mollienisia, common, 9
latipinna, 9
sail-finned, 9
velifera, 9
Mosquito fish, 8
Motion pictures, 103, 123
Mowbray, L. L., 85, 139
Musgrave, M. E., 186

N

National Broadcasting Company, 143, 173
Nelson, E. W., 184
New deep-sea fish, 175
New members, 104
Nieremberg, Juan Eusebius, 80
Nigrelli, R. F., 123
Noback, Charles V., 140, 185, 195
Nonsuch: Land of Water, 39
Notes on bower-birds in Zoological Park, 65
Nourmahal, 107

O

Ogilby's "America", 80
O'Keefe, C. F.,
Oryzias latipes, 13
Osphromenidae, family, 9

P

Panchax, chaperi, 8
Chapter's, 8
linaetus, 8
striped, 8
Paradise fish, fork-tailed, 9, 21
round-tailed, 9
Parasites, 123
controling and eradicating, 127
Parasitism, 75
Parvin, R. G., 186
Pepper trees, 62
Phalloceros caudomaculatus, 9
Platypoecilus couchianus, 9, 17
Pomacentrus leucorus, 121
Prionodura newtoniana, 55, 57
Pronghorn of North America, The, 183
census of, 185
U. S. Forest Service, 187
deciduous horns of the, 195
development of horn, 197
horns, shed, 205
Pseudoscopelus stellatus, 41
Pterois volitans, 31
Ptilonorhynchus violaceus, 55, 61

R

Rachford, C. E., 186
Reef fishes, East Indian, 121
Remora, 73
barracuda, 75
fishing in West Indies, 76
observations, 81
louse-fish, 75
off-shore, 75
shark, 75
spearfish, 75
swordfish, 75
Robson, G. C., 178
Ruby jewelfish, 9

S

Saccopharynx harrisoni, 40
Sanborn, Elwin R., 139, 207, 213
Scenopaeetes dentirostris, 59
Schiff, Mortimer L., 40, 96
bequest, 96
Schinus molle, 62
Scientific value of small aquarium fishes, 10
color changes in fishes and medicines for man, 10
lessons learned from studies of laboratory animals, 12
world-wide interest in aquarium fishes, 13
studies on phases of life history, 13
examples in heredity, 17
cancer research, 17
Scorpion fish, 31
Scott, J. T., 186
Sericulus melinus, 57
Shark, 73
Shark-sucker, 73
Sharp, George, 57
Siamese fighting fish, 9, 21
Smith, Homer, 134
Snake Island, 93
Spaeth, biologist, 11
Splashing salmlet, 22
Stewart, Warren C., 81
Strombus gigas, 72
Sullivan, J. E., 186
Surucucu, 213
Swenson, Thoralf, 186
Swordtail, Mexican, 9, 15, 17
Symbiosis or mutualism, 71

T

Testudo ephippium, 93
Tee-Van, John, 37, 43, 146
Thalassoma bifasciatum, 43
nitidum, 43
Tilapia dolloi, 9
Top minnows, 8
Trematodes, monogenetic, 123
Tropical Research, Department of, 35
contributions published, 93
new laboratory, 35
operations of department in, 1932, 142
Townsend, Charles H., 84, 85, 107, 123, 133, 137
presentation to, 139

U

Ultra-violet light machine, 39
development of modern heliotherapy, 50
irradiating deep-sea fish, 49
modern uses of, 50
radiation, A new use of, 49
Upton, Mrs. Dorothy Binney, 209

V

Vanderbilt, W. K., 93
Vaupel, Jean, 14
Vogt, George, 209

W

Wheeler, J. F. G., 41, 142
Williams, Harrison, 40
Wilson, Geo. K., 186
Winge, 15
World of Bermuda fish, The, 36
deep-sea fish recorded, 37
catalogue, 38
submerged beach discovered, 39
dredging, 40
Wrasse, blue-head, 43
tracing deelopment of color, 45
color units, individual changes, 45

X

Xiphophorus hellerii, 9, 13, 15, 17

Y

Young animals, 93

Z

Zebra fish, 31
Zetek, James, 215

ILLUSTRATIONS

A

Aequidens latifrons, 18
Ambasis lala, 6
Anabas scandens, 28
Ant-eater, great, 99
Aquarium, interior and exterior, 124
new department, interior, 6
Arctocephalus townsendi, 138
Argyropelecus hemigymnus, 144
Armadillo, nine-banded, 52
Astor, Vincent, 108
Australian homestead, 54

B

Baboon, chacma, 98
Balistipus aculaetus, 116
Balistis sp., 110
Barbus ticto, 5
Barracuda, 133
Bat, brown, 99
Bathysphere, about to descend for test dive, 153
adjustment of oxygen valves, 160
after two hours confinement in, 172
appearing after test dive, 155
ascent, breaking surface, 170
at wharf ,148
awaiting zero hour, 159
Beebe and Barton inside, 162
broadcasting, 161, 166
station ZFB, on deck of Freedom, 173
camouflaging, 147
crashing against steel winch, 157
descending, 166
door swung over bolts, 163
dropping beneath surface, 165
during the dive, 167
emerging from, 171
entering, 161
examining details of, 159
giant steel sheeves, 151
giving final instructions, 162
Gloria Hollister after dive, 174
recording sounds, 167
greatest depth reached, 170
hoisting, 148
inspecting, after test dive, 156
lashed to deck, 152
loading the, 160
nuts screwed into place, 164
on deck of Freedom, 149
opening door of, 158
overhauling, 147
painting, 146
photographs under water, 168
placing white lead on flange, 163
pounding wrench, 164
preparing for test dive, 153
swing aboard after test dive, 155
swing outward, clearing rail, 165
testing steel cable, 149
unscrewing wing bolt, 171
winch, 151
zero hour, 142
Beau gregory, Galapagos, 120
Belonesox belezanus, 6
Bermuda, Map of, 150
Betta splendens, 2
Bison and young, 102
Black-banded limia, 7
Bower bird, satin, male, 56
bower and site of, 59
near Sidney, 63
fawn-breasted, Cover No. 2, 64
bower of, 67
immature, satin, male, 68
twigs "painted" by, 58
Brachydanio rerio, 19
albolineatus, 19
Brook barb, 5
Bullheads, 128

C

Capybara, 53
Carangoid fish, 71
Carnegiella strigata, 23
Casarab, 7
Catfish, 75
Ceiba tree, 220
Cephalopholis argus, 113, 114
Chaetodon setifer, 117
Chiasmondon niger, 34
Chimpanzee, young, 52
Cichlids, elongate, 8
broad-headed, 18, 20
young, 21
Coati-mundi, 99
Contour shore diving, 176
Couch's platy, 7
Crab "eyed", 114
Crenicichla lepidota, 8

D

Danio, zebra, 19
pearl, 19
Deep-sea fish, new, 175
pebbles, 39
specimens, 169
Deer, white-tailed, 51
Distribution of pronghorn (Map), 196
Dovekie, 206
Dragons, black, Cover No. 5

E

Echiostoma ctenobarba, 48
Eels, electric, 130
Electrophorus electricus, 130
Ephinephelus, 113
Eques acuminatus, 132
Evoplites viridis, 111

F

Fer-de-lance, 218
Fish trap, 121
Fish parasites, stages of development, 126
Flammeo, 106, 117
Flying characins, 23
squids, 178
Fur seal, California, 138

G

Gasteropelecus sternicla, 23
Glass fish, 6
Golden-tail, 132
Gorilla chart, 140
Gourmand, deep sea, 34
Groupers, 114
Galapagos, 115

South Sea, 113
Tahiti, 115
Grouse, black-bellied sand, 52
Grunts, 111
Gulper eel, 38
Guppy, 25

H

Haemulon, 111
Hedgehog, European, 53
Hemicromis bimaculatus, 22
Hemigrammus ulreyi, 5
Holbrook, John Edwards, 136
Holocentrus, 117
Howler monkeys, 214

K

Kudu, young, 101
and young, 101
Lantern-fish, 37
Lebistes reticulatus, 25
Limia nigrofasciatus, 7
Lobster, locust, 118
Tahitian spiny, 118
Lung-fish, 135
Lutianus sp., 116
Lydig arch, 95

M

Map of Cuba, old, 76
of World, 24
Markhor, 102
Melichthys radula, 110
Mexican platyfish, 11
Microspathodon chrysurus, 132
Mid-water fish, 179
Mollienisia velifera, 9
Mountains of Panama, 212
Mud springer, 26
Myropristes, 117

N

Nourmahal, The, Cover No. 4, 109

O

Ogilby's classic, "America", 78
Owl, milky eagle, 51

P

Panamanian forest jungle, 210
Panchax lineatus, 2
striped, 2
Paralabrax maculatofasciatus, 114, 115
Parrotfish, giant blue, 180
Peafowl, Javan, 98
Pelican, dalmation, 53
Penguin, Galapagos, 122
Perch, climbing, 28
Periopthalmus koetreuteri, 26
Photomicrograph—platyfish, 12
Pike killie, 6
Piranha, 29
Platyfish, 6
diagram, 13, 14, 15, 16
Mexican swordtail, 16
Platypoecilus couchianus, 7
maculatus, 6
Political bathysphere, 154
Polycentrus leucorus, 120
Porcupine, spiny tree, 100
Portuguese man-of-war, 72
Pronghorn antelope, Cover No. 6, 182, 188-194
horns, showing annular rings, 197
horns, 198-204
Pseudoscopelus stellatus, 37
Pterois volitans, 30
Pterophyllum scalare, 27

R

Reef fishes, 112
Regent bird's haunt, 60
Remora, Cover No. 3, 92
fishing (drawing), 83
(map), 70
lifting pail, 84
used to catch sea turtles, 82
Rocky Mountain sheep, 102
Ruby jewelfish, 22

S

Saccopharynx harrisoni, 38
Sail-finned mollienisia, 9
Sea turtles, 119
Serrasalmo rhombeus, 29
Shark and shark sucker, 86, 87, 88, 89, 90
with sucking fish, 73
as bait for fishing, 76, 77
leashed by natives, 81
method of attachment to canoe, 81
tail of, 80
Shark-sucker showing disc, 74
natives fishing with, 80
Siamese fighting fish, 2
Silver hatchetfish, 144
Snake Island, 97
Snappers, yellow-striped, 111
South Sea fishes, 117
Sturgis, Frank Knight, 94
Sun lamp, 48
Swan whooping, 51

T

Tahiti fishes, 116
Tahr, Himalayan, 100
Toucan, 216
Trigger fishes, 110
Tropical Research Department, future home, 36
Headquarters 16th expedition, 141
Tropical jungle, 217
Turtles, sea, 119

U

Ulreys characin, 5

W

Wrasse, blue headed, 44

X

Xesurus, 117

Y

Yak and young, 100

Z

Zebra fish, 30, 32
Zebra, Grant, 98

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VOL. XXXV, NO. 1 January-February, 1932

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Vol. XXXV, No. 1 January-February, 1932

Contents

Siamese Fighting Fish and Striped Panchax.....*Frontispiece*
New Department at Aquarium.....*C. M. Breder, Jr.* 3
Scientific Value of Small Aquarium Fishes.....*Myron Gordon* 10
Family Life of Small Fishes.....*C. W. Coates* 17
An Interesting Scorpion Fish.....*C. M. Breder, Jr.* 31

Illustrations

Interior of Aquarium
Brook Barb
Ulrey's Characin
Pike Killie
Platy Fish
Glass Fish
Casarab
Black-banded Limia
Couch's Platy
Elongate Cichlid
Sail-finned Mollienisia
Mexican Platyfish
Photomicrograph—Platyfish
Diagram—Platyfish
Diagram—Platyfish
Diagram—Platyfish
Platyfish and Mexican Swordtail
Broad-headed Cichlid
Zebra Danio
Pearl Danio
Broad-headed Cichlid
Broad-headed Cichlid—Young
Ruby Jewelfish
Flying Characins
Map
Guppy
Mud Springer
Crescent Fish—Balanced Aquarium
Climbing Perch
Piranha
Zebra Fish
Zebra Fish

Crescent Fish—N. Y. Aquarium.....*Cover*

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Upper: Siamese Fighting Fish, *Betta splendens*. *Lower*: Striped Panchax, *Panchax lineatus*. These plates are representative of the results obtained in experiments to date, in natural color photography under water. Photographs by B. R. Sherwood.

BULLETIN
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A New Department at the Aquarium

C. M. BREDER, JR.

Illustrations from photographs made in the N. Y. Aquarium, unless otherwise noted.

ANY institution devoted to the exhibition of living animals must necessarily limit its displays to forms which will exist under the conditions it is possible to provide. The New York Aquarium was originally planned to display temperate, marine and fresh-water fishes and tropical marine fishes, as well as those semi-aquatic forms which require large basins of the "floor pool" variety. Various changes and improvements on the basic scheme have been made from time to time as the need for them arose. They were adequate for the purposes in mind and essential modifications for the institution to make.[1]

In the thirty years that these alterations have been going on there arose a popular interest in small fishes that today is supported by an industry of no mean proportions. At the beginning of this period practically the only species available for the home aquarium was the goldfish, aside from a few native forms not particularly well suited for such places. In the early part of this century a few, small, tropical fresh-water fishes had found their way into the private aquaria of persons with more than a passing interest in such matters. Due to their brilliance or striking habits these increased in popularity. When it became thoroughly realized that many of them were ideally suited to small tanks and required little more than a simple aquarium of the *proper temperature* their permanent acceptance as objects of fish culture became assured. As a result there are today between two and three hundred species in American aquaria with new forms being continually imported.

It has long been the desire of the Aquarium to be able to exhibit fishes of this type in a representative collection, partly because of their various intrinsic items of unusual interest and attractiveness and partly because of the great hold they have on the average aquarium visitor. In fact the institution would not be living up to its best traditions if it did not make every effort to provide the necessary equipment for the proper housing of such specimens.

Because of the aforementioned considerations it was, therefore, with considerable satisfaction that on December 14, 1931 a new department was opened entirely devoted to the exhibition of fishes that may be kept in balanced tropical fresh-water aquaria. The exhibition tanks proper consist of twenty-four, three-gallon and forty-eight, twenty-gallon aquaria arranged in a double row. In addition to this section of the exhibit there is a "room" behind a glass pane in which a model aquarium is established in order to render to the public a perfectly clear idea of what may be done with such an outfit within the dwelling of man. In addition to the aquaria there are eight terraria which give a similar idea of what may be done with the smaller amphibia and reptiles.

[1] An examination of the Annual Reports for the past twenty-five years will give the interested reader a complete history of this work.

JAN 14 1932

General view of the new department. Photograph by S. C. Dunton.

Demonstration alcove showing household aquarium and a bowl terrarium. Photograph by S. C. Dunton.

Interior of small aquarium "hot house" showing working space, breeding, experimental and stock aquaria. Photograph by S. C. Dunton.

Brook barb, *Barbus ticto*. These specimens have abnormally developed eyes somewhat similar to those of the "telescope" goldfish. In the present case they are rotated downward and especially prominent in the front view. This type of abnormality is not common. Photograph by S. C. Dunton.

The sizes and numbers of exhibits are limited entirely to the space available. In other words the gallery now presents a continuous circuit from the entrance staircase to the exit and there is consequently no further room for expansion on this level. The numbers and species of small tropical fishes that can be shown are, therefore, somewhere in the neighborhood of two hundred and fifty, allowing something over three species, on the average, to an aquarium. At the opening there were one hundred and eighteen species displayed which may be considered a good representative showing, especially as there are among them some of the

Ulrey's characin, *Hemigrammus ulreyi*. A small and attractive aquaria fish from Paraguay. Photograph by S. C. Dunton.

The Pike killie, *Belonesox belezanus*. The largest of the viviparous killies. This species, unlike most of its relatives, is a voracious and predaceous fish. It is not common in home aquaria. Male left. Female right. Photograph by S. C. Dunton.

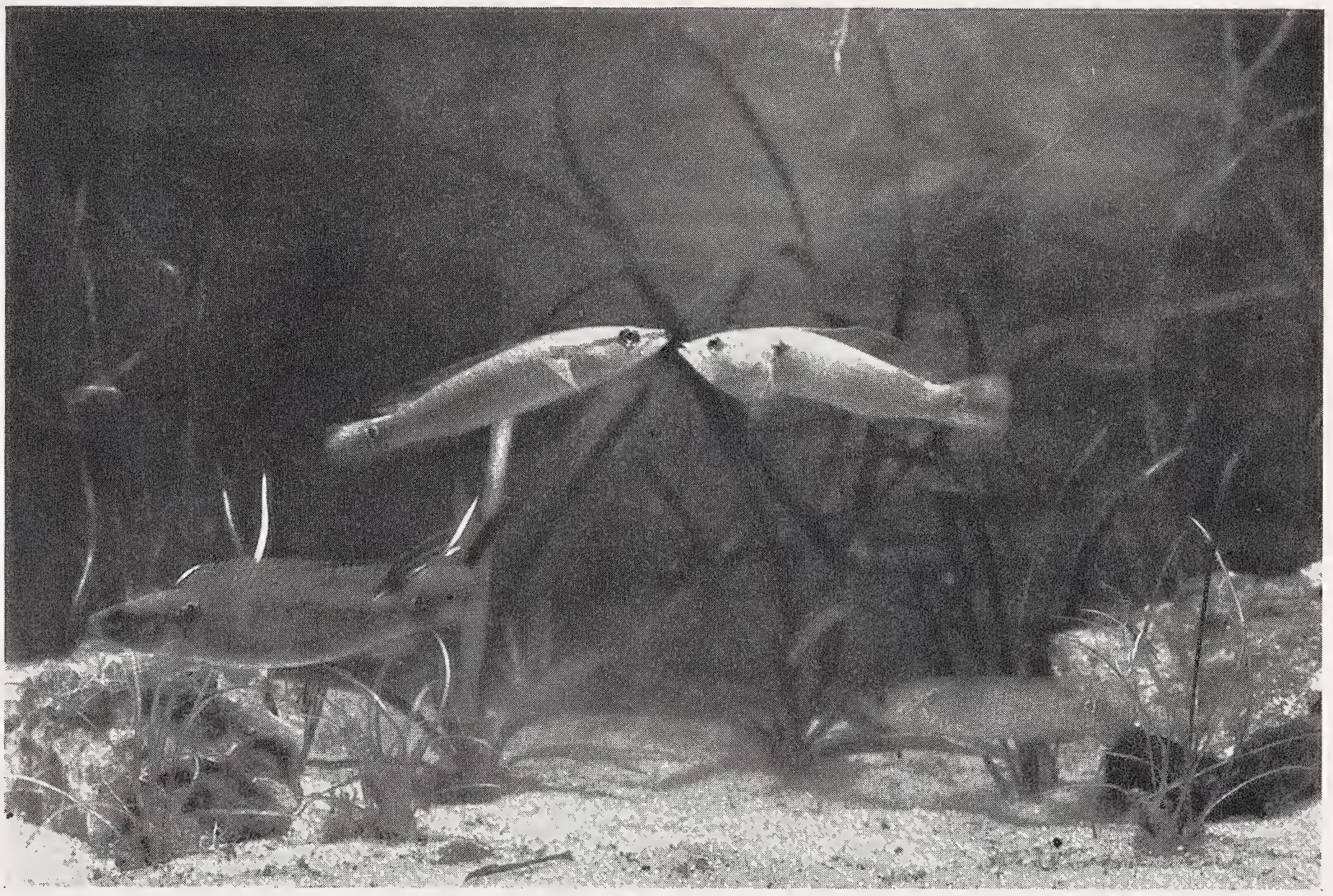
Platy fish, *Platypoecilus maculatus*. A viviparous species very popular in home aquaria. It has a large number of genetical variations. See the article by Myron Gordon in this number of the Bulletin. This picture shows the "nigra platy." Photograph by S. C. Dunton.

Glass fish, *Ambasis lala*. A remarkably transparent fish from India. This photograph has been taken with most of the light coming from behind. The internal anatomical details are as clear as in many radiographs. Note especially that even in the diagonal view some of the details are clearly evident. Photograph by S. C. Dunton.

Casarab, *Polycentrus schomburgki.* A curious little fish much given to changing the depth of its color and to "sitting" propped up on the sand. Both these features are shown here. The tail of this species is of such transparency as usually to be quite invisible, giving the fish a rather abbreviated appearance. Photograph by S. C. Dunton.

Black-banded limia, *Limia nigrofasciatus.* One of the less familiar viviparous aquarium fishes. Photograph by S. C. Dunton.

Couch's platy, *Platypoecilus couchianus.* A new aquarium fish brought from Mexico in 1930 by Dr. Myron Gordon. Photograph by S. C. Dunton.



Elongate cichlid, *Crenicichla lepidota*. A slim relative of the broad-head cichlid. Here they are shown having some sort of minor disagreement. Photograph by S. C. Dunton.

less well known forms. The accompanying illustrations, from negatives all taken in our tanks, represent a fair sample, although all lose heavily when reduced to the monochrome of an ordinary photographic print.

The backing on which this department rests is a small room of greenhouse construction in which many species are spawned, reared and studied. This workroom which is not open to the public contains about one hundred small tanks of fishes of various degrees of development, special strains, breeding pairs et cetera. Only the best available fishes of any given species are on display. Also in this room various experimental work is in progress of both a biological and fish-cultural nature. It may be said in this connection that these fishes so eminently satisfactory for aquarium culture make this department the only one in which the natural increase in numbers far exceeds the natural death rate. In all other departments of this Aquarium, or other similar institutions, the reverse is and always has been the case for the simple reason that successful reproduction in aquaria of other types of fishes is always relatively scant and uncertain. Pertinent to this is the following list of species that have already reproduced in this department. This has been in the face of confusion, shifting of fishes, insufficient attention and other detrimental items always associated with the establishment of an entirely new department within an old organization.

Barbs (Family Cyprinidae)
Rosy Barb *Barbus comchonius*
Day's Barb *Barbus vittatus*
Malabar Danio *Danio malabaricus*
Zebra Danio *Brachydanio rerio*

Loaches (Family Cobitidae)
Common Loach *Cobitis fossilis*

Killifishes (Family Cyprinodontidae)
Striped Panchax *Panchax lineatus*
Chaper's Panchax *Panchax chaperi*

Top Minnows (Family Poeciliidae)
Texas Gambusia *Gambusia affinis*
Mosquito Fish *Heterandria formosa*

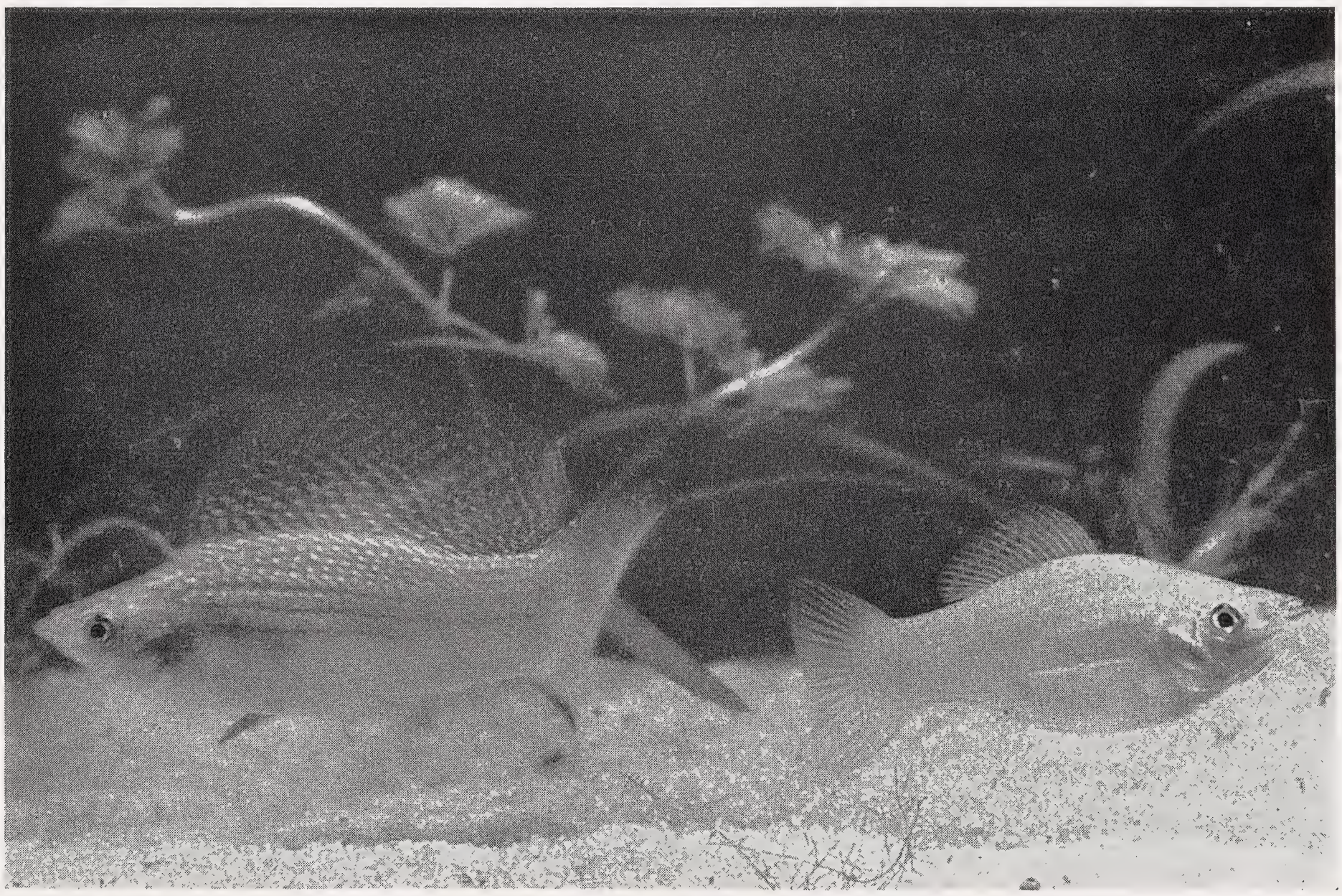
One-spotted Killie *Phalloceros caudomaculatus*
Guppy *Lebistes reticulatus*
Couches Platy *Platypoecilus couchianus*
Platy Fish *Platypoecilus maculatus*
Mexican Swordtail *Xiphophorus helleri*
Blackbanded Limia *Limia nigrofasciata*
Common Mollienisia *Mollienisia latipinna*
Sail-finned Mollienisia *Mollienisia velifera*

Gouramies (Family Osphromenidae)
Fork-tailed Paradise Fish *Macropodus opercularis*
Round-tailed Paradise Fish *Macropodus chinensis*
Siamese Fighting Fish *Betta splendens*

Cichlids (Family Cichlidae)
Broad-headed Cichlid *Aequidens latifrons*
Ruby Jewelfish *Hemichromis bimaculatus*
Dollo's Tilapia *Tilapia dolloi*
Egyptian Mouth Breeder *Haplochromis strigigena*

As an indication of the interesting breeding habits which these fishes have, reference to the above list may be made. Those forms mentioned, down to the top minnows all lay adhesive or free eggs the former of which adhere to various submerged objects and hatch out in a certain time dependent on the species and the water temperature. The top minnows on the other hand bring forth active young which are immediately able to shift for themselves. The gouramies listed above all build nests composed of mucus-covered bubbles in which the eggs are placed by the male who then cares for and protects them and the resulting young. The broad-headed cichlid constructs a nest in the sand and is usually very solicitous about the care of the offspring.[2] The ruby jewelfish which attaches its eggs to a rock is also industrious in the care of its offspring. The accompanying photographs both show evidence of this. It so happens, however, that the picture of the ruby jewelfish attacking a finger is a rather unusual case. The fish is a female which deposited the eggs in the absence of a male. They were thus unfertilized and incapable of

[2] For details see the accompanying article by C. W Coates.



Sail-finned mollienisia, *Mollienisia velifera*. A Yucatan species rare in small aquaria. The male has a greatly enlarged dorsal fin. The better developed males of the common mollienisia sometimes erroneously pass for this species. Photograph by S. C. Dunton.

developing. Never-the-less the fish evidently took much interest in them, although it is normally the male which tends the eggs. By the time the photograph could be taken she had already eaten a number which is more nearly normal for the female of this species, despite the fact that she resented intrusion.

The last two species in the preceding list both carry their eggs about in their mouth during incubation and for some time thereafter. It is thus clear that there is great variation in the habits of these fishes as indeed might be expected as they represent a wide divergence in biological relationships and are of world wide distribution in the tropics.

The accompanying map shows the native homes of all the species present at the opening of this new department. Although these regions have by no means been exhausted, a truly remarkable number and variety of species may be obtained from dealers in such fishes, located for most part in or close to our larger centers of population.

This new department has been established with as many fine specimens as could be obtained at reasonable cost both by purchase and direct importation. It is to be clearly understood, however, that it is only to be looked upon as a start and it is confidently expected that the exhibits will show a continued improvement in quality until a point is reached when the New York Aquarium will be showing specimens of small aquarium fishes only of exceptional merit.

For the purpose of maintaining a satisfactory type of collection, the New York Zoological Society accepted a sum of money to be known as the Damon Fund, the income from which is to be used for the purchase of specimens for this new department. This fund was established in 1930 by Mrs. William Emerson Damon in memory of her husband who had a life long interest in home aquaria and the study of species suitable for such places. A tablet is to be placed close to the exhibit in commemoration of Mr. Damon's devotion to such matters.

It might be easily thought that these diminutive fishes have significance only as ornamental objects, of interest alone to the amateur naturalist. That this is not the case is clearly shown in the accompanying article by Dr. Gordon, in which he sets forth the more evident scientific problems in which such fishes have played important roles. Referring also to the article by C. W. Coates, a little reflection will convince the most skeptical that many general problems, touching on diverse fields, can be well illuminated by a consideration of these fishes so ideally suited to domestic quarters of small size.

The Scientific Value of Small Aquarium Fishes

MYRON GORDON[1]

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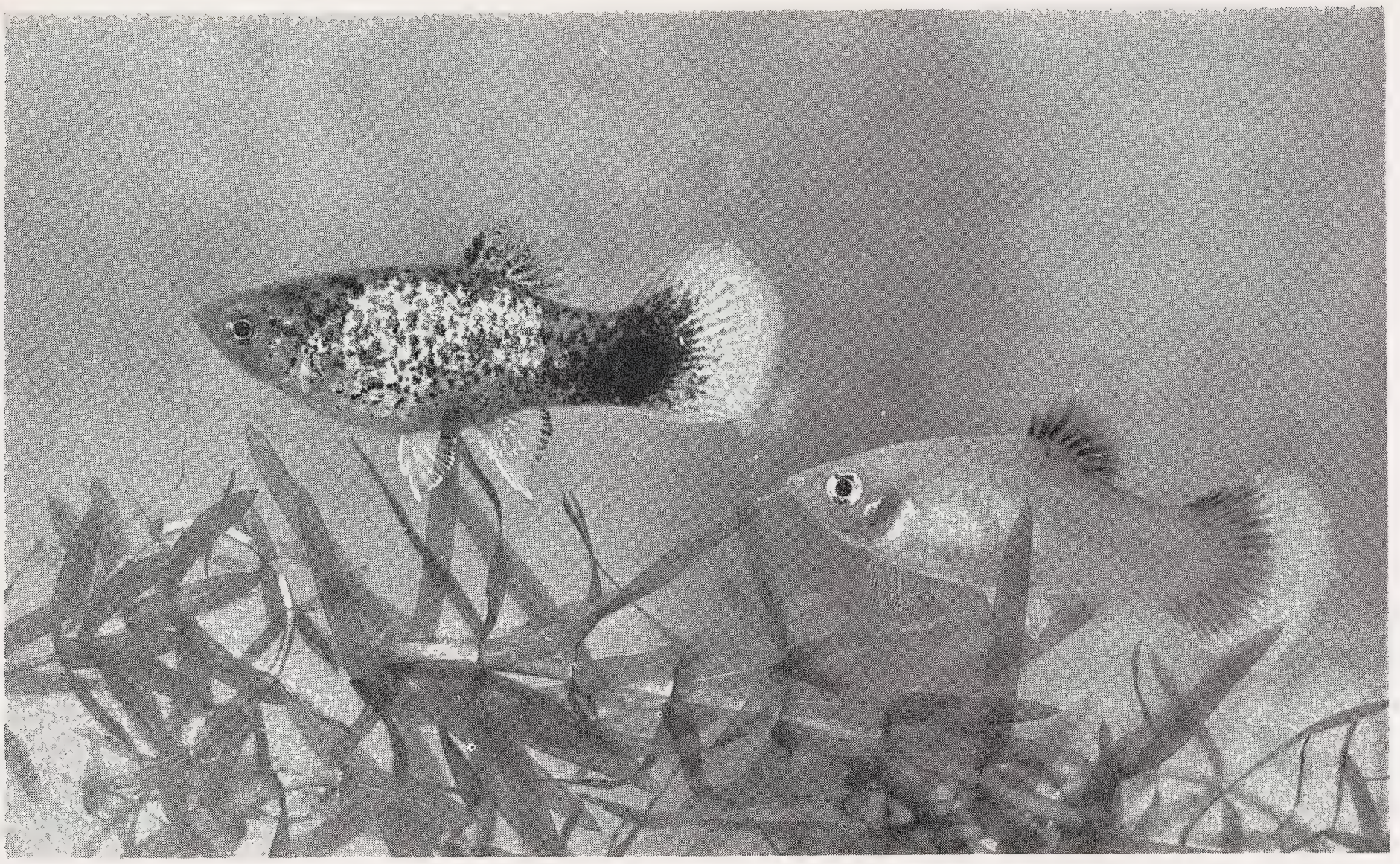
THE popularity of tropical aquarium fishes is easily understood by those who have observed their beautiful, flashing colors, have followed their quick, darting movements through the water and have studied their fascinating breeding habits. The hobby of tropical fish keeping and breeding has given pleasure and recreation to thousands. It has served as a method of self education, and it has given to many their first introduction to the biological world. These are good and sufficient reasons for encouraging and assisting the hobby of the aquarist.

And now these tropical aquarium fishes are being used in biological and medical laboratories by investigators who hope to solve many important problems by applying scientific methods.

COLOR CHANGE IN FISHES AND MEDICINES FOR MAN

While the layman derives full pleasure from the observation of the life within the aquarium, the biologist is urged to investigate the why and wherefore of the observed activity. The aquarist will gaze with wonder upon the rapidity of color change in some aquarium fish. One moment the fish may appear quite dark, hiding, hardly visible, in the shadow of a plant

[1] Investigator, Project No. 106: STUDIES ON THE ORIGIN OF NEOPLASTIC DISEASES (MELANOSIS) IN FISHES, supported by the Heckscher Foundation for the Advancement of Research, established by August Heckscher at Cornell University, Ithaca, N. Y.



Mexican platyfish, *Platypoecilus maculatus.* The fish on the left is a female spotted (and stippled) platy. On the right, the fish is the gold platy. When these two fishes are mated, the inheritances of the spotted character may be traced through the succeeding generations. For results of a cross of this type, see the accompanying diagram. Photograph by Myron Gordon. (From Fraser and Gordon.)

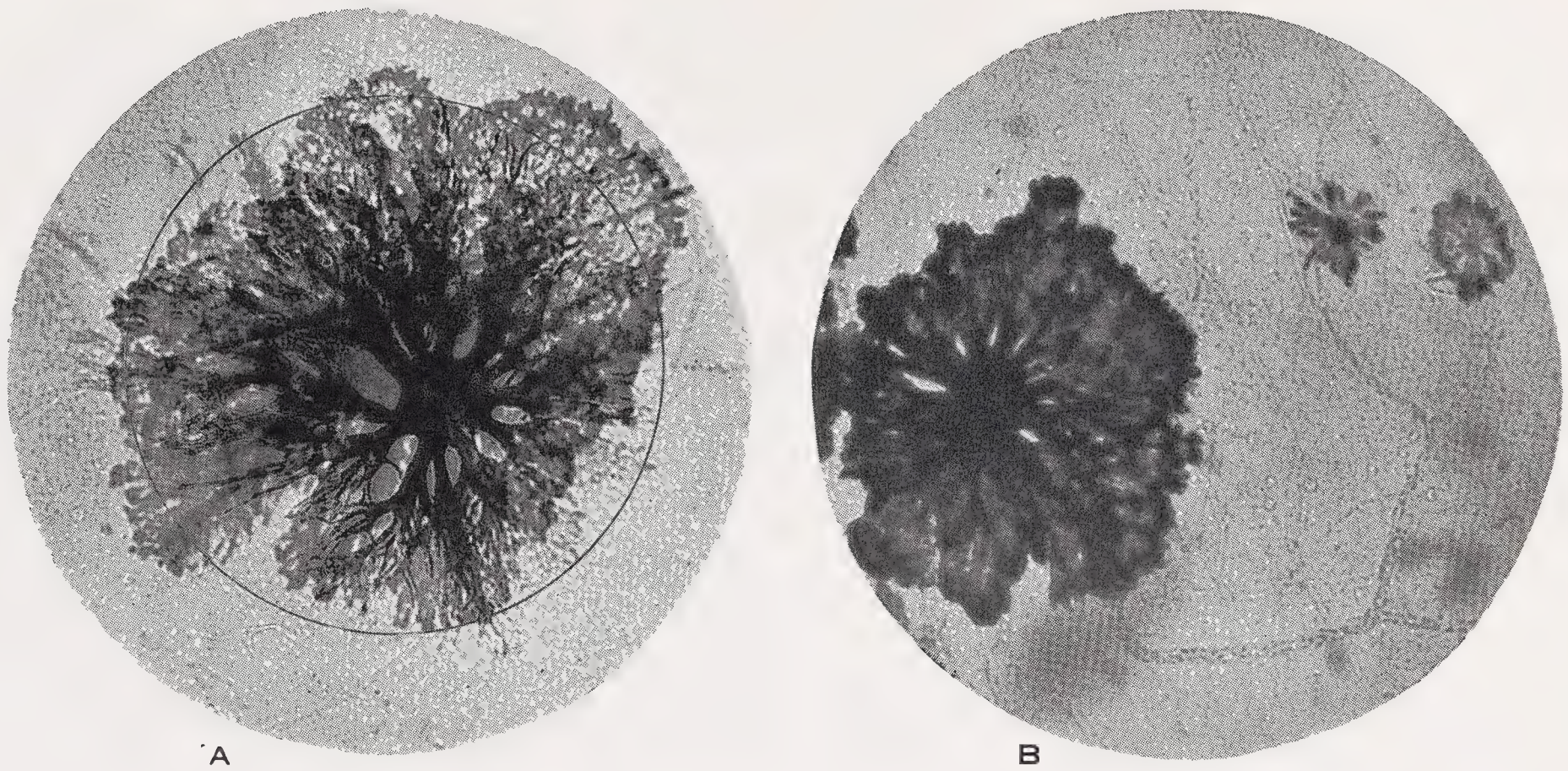
or rock; the next instant, darting out into the open sun-lit places it turns extremely pale—and again becomes practically invisible.

The biologist by placing the fish carefully upon the stage of his microscope and, by applying a mild harmless stimulant, causes a similar color change to be enacted. The biologist sees through the microscope the amazing cellular mechanism involved in the process of color change. He sees that the pigment particles in the skin are not scattered diffusely but are confined within definite cells, the chromatophores.

When a person "turns white as a sheet," the actual reaction involved is a temporary withdrawal of the normal blood supply from the face. Color change in the skin of fishes is brought about by an entirely different method. When the nervous state of the fish is such that it demands a dark exterior, black pigment particles actually move outwardly along definite processes which radiate in all directions from the centre of the cell. In this expanded state the chromatophore has the appearance of a wheel with its hub and spokes. The pigment particles darken a large area of the skin surface. The pale or contracted state is brought about by the withdrawal of the pigment particles from the radial processes to small globular masses within the centre of each cell.

Some chromatophores contain black coloring matter (melanophores), some have red (erythrophores) and others yellow (xanthophores). Blue color and iridescent effects are due to reflecting guanin crystals in cells called iridiophores. By means of an elaborate nervous mechanism, some of these cells, at a given moment, may become contracted, while others are expanded. Consequently, many different and complex color schemes may be manifested by the same individual. In most cases, color changes are automatically controlled by the nervous system, guided by receptive end organs situated in the eyes. A blind fish does not respond to the color of its environment.

Chromatophores of fishes are delicately sensitive to the effects of certain drugs. Little did Biologist Spaeth realize, at the time he made his early observations on the movement of pigment granules within the color cells of the common killifish, *Fundulus heteroclitus,* and noted the effect of various stimulants upon them, that out of his studies would come information of



A. Photomicrograph made by a double exposure. A partially contracted large black pigment cell (macromelanophore) is superimposed upon a partially expanded one. The limits of the first are contained within the circle. In the contracted state, note the narrow black processes formed by the pigment particles. In the expanded condition the pigment particles are arranged in sheets. It is by a process of pigment cell expansion and contraction that color changes in fishes take place. B. This picture is a photomicrograph of the black pigment cells of the spotted and stippled platyfish. The spots of the platy are due to large black cells called macromelanophores. The gray ground color of the platy is due to the smaller pigment cells, micromelanophores. Note the blood vessel which reaches each pigment cell, both the large and the small. Photographs by Myron Gordon.

great practical value to mankind. Spaeth worked out the standard biologic potency of many drugs valuable to man by testing their effect upon the direction and rapidity of motion of the pigment particles in the fish chromatophore.

Lessons Learned from Studies of Laboratory Animals

The laboratory rat has atoned for the sins of its wild progenitors. It has made possible the discovery of new and extremely useful facts, particularly in the fields of nutrition and heredity. The experimental production, as well as alleviation, of scurvy and rickets in laboratory animals has pointed out the way for the prevention of these deficiency diseases in children.

Modern breeding methods in animal husbandry have grown out of discoveries made with the smaller laboratory animals. The mating of brother and sister rats, generation after generation, which constitutes the closest type of inbreeding, has taught us that loss of vigor does not necessarily follow. Indeed, this practice often intensifies the good qualities. Inbreeding is used with success in the standardization of desirable characters and leads to the establishment of new and better stock. We have also learned that virility does not always result from mating of individuals belonging to two unrelated stocks. We have come to realize the true power of heredity and its relation to environmental factors.

The establishment of principles of heredity in fishes is a laborious task: yet this work must precede practical recommendations for fish cultural practices. Tropical aquarium fishes have been used with great success in throwing light on the hereditary processes. They are destined to be as useful to the practical fish culturist as the laboratory rat and guinea pig have been to the animal husbandryman. Tropical fishes have all the requirements for a useful laboratory type, for they are small, require comparatively little space and they have a short life cycle.

Workers in aquatic biology must soon arrive at the conclusion that all their efforts to improve fish cultural practices and fishing must not be confined to the study of environmental factors alone. They will learn, as the workers in animal husbandry have learned, that it is cheaper in the long run to develop disease resistant strains of fish, than to treat diseased fishes of weak, mixed heredity. Building of worthy, rapidly growing, disease resisting stocks is one of the most complicated and difficult tasks

of the geneticist, yet modern plant and animal pathologists look to this method as the most promising for permanent gain.

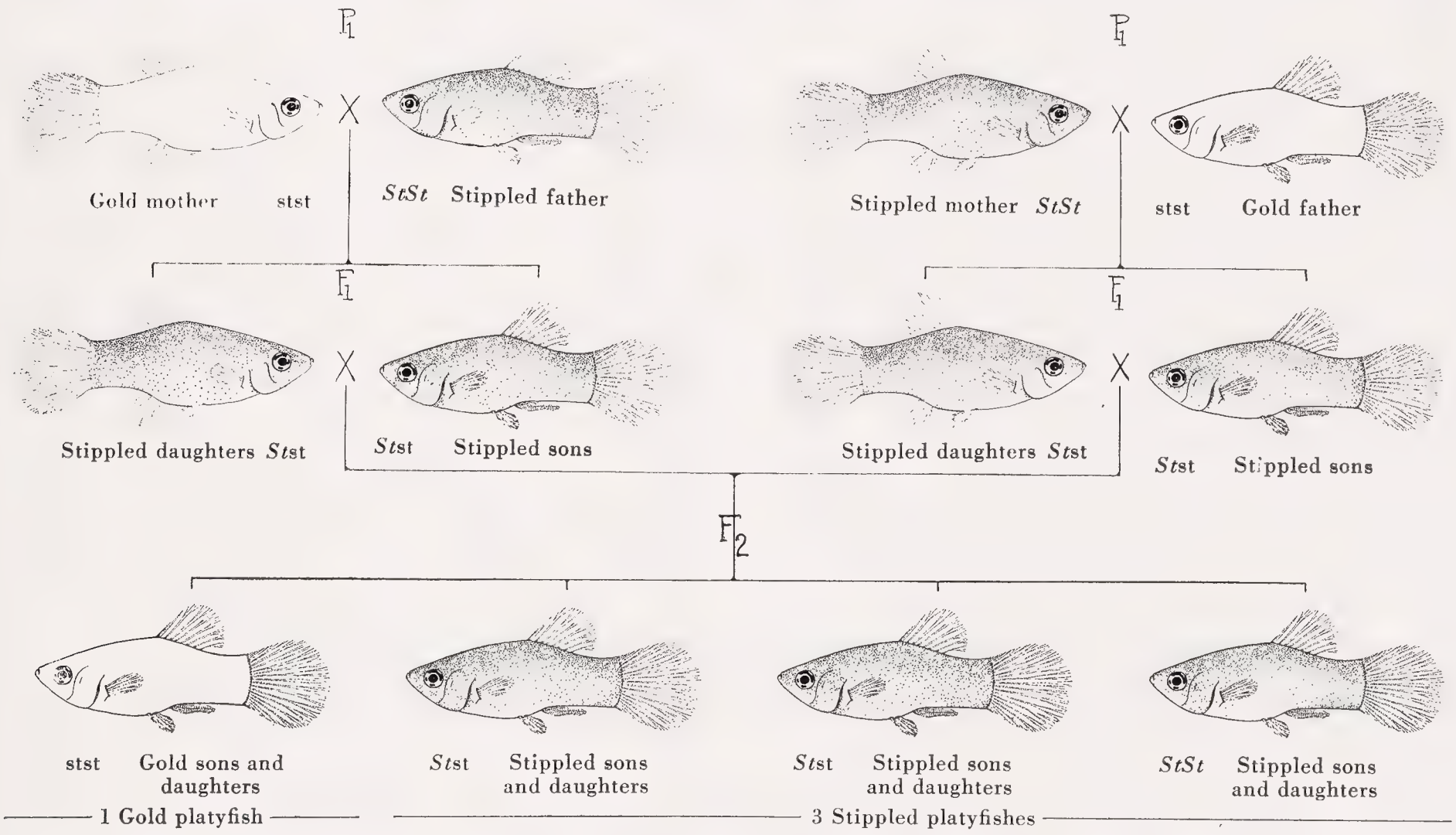
World-Wide Interest in Aquarium Fishes

Research with tropical aquarium fishes is an international affair. Fishes from many parts of the world furnish material to scientists working in laboratories of many different countries.

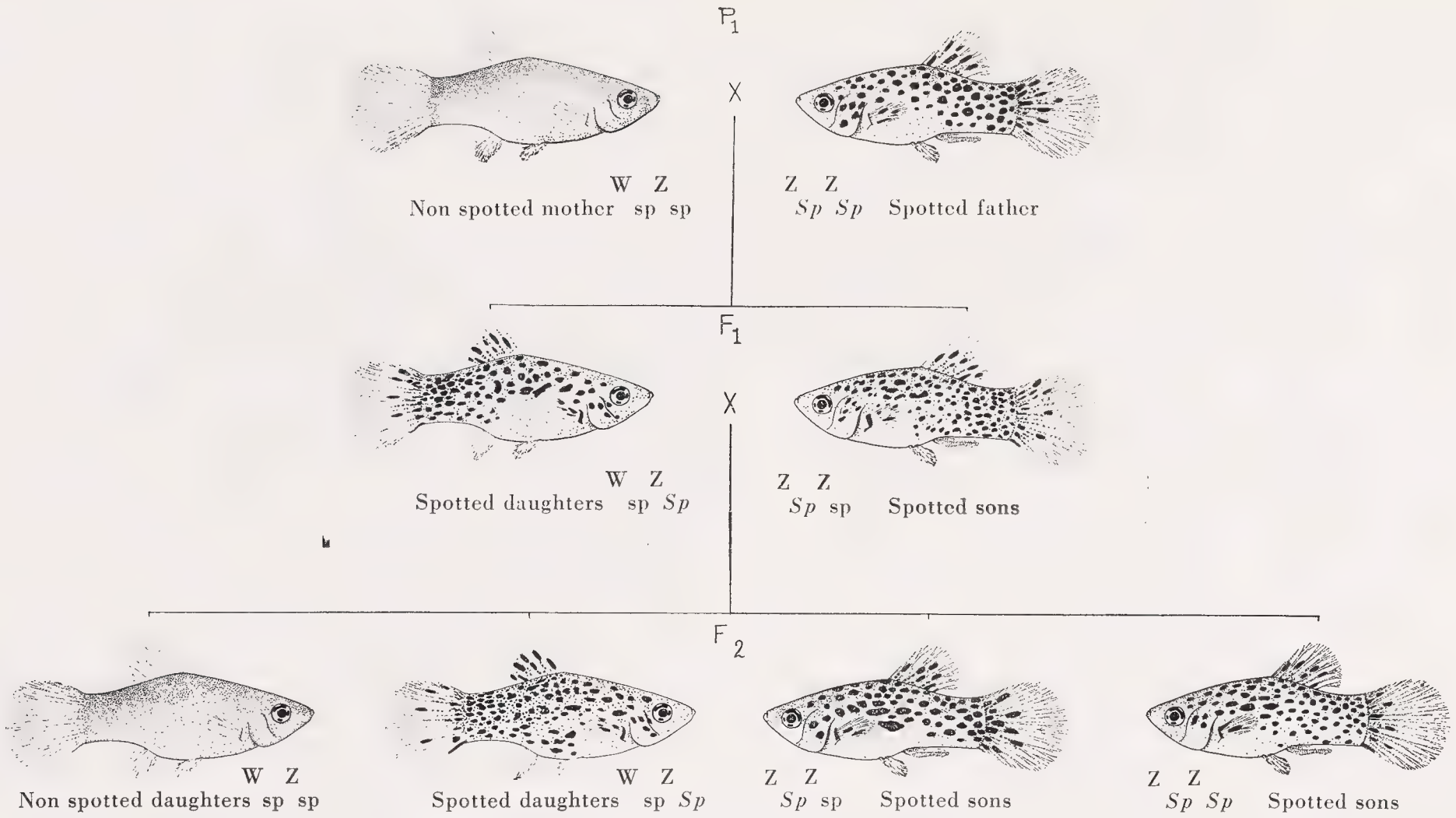
The most common of all tropical aquarium fishes, the guppyies (*Lebistes reticulatus*) are natives of Trinidad and neighboring islands in the West Indies. Now they may be found in the biological laboratories at Copenhagen, Moscow and Berlin, and in many Universities of the United States. The platyfishes (*Platypoecilus maculatus*) and swordtails (*Xiphophorus hellerii*) were originally found far up the Rio Papaloapan, near the boundary of the Mexican states of Vera Cruz and Oaxaca, at the small settlement of Obispo. Now they may be seen swimming contentedly in laboratory aquaria in Germany, Denmark and in the United States, California, Illinois, Texas and New York. The beautiful striped Danio, (*Brachydanio rerio*) a native of the warm streams of far off India is now being studied at Wesleyan University in Connecticut and in the College of the City of Detroit. The medaka, the killifish of the Japanese rice fields (*Oryzias latipes*) is now well known to American geneticists through the careful work of Aida in Tokio. It has been brought to this country also and is being studied further. The real work in fish genetics was started only about ten years ago. Judging from the important work that has already been done, tropical aquarium fishes should certainly play a significant part in biologic research in the future.

Studies on Phases of Life History

The life histories of most of our aquarium fishes are still undescribed. We do not know very much about the method of evolution of viviparity (the method of reproduction which involves the birth of living young). Consider in this connection the fishes of the order Cyprinodontes. In this group we have fishes like Fundulus which are strictly oviparous; then we have the interesting intermediate group like Oryzias, the medaka, where the female holds the fertilized eggs in a thin sac, close to her



This diagram illustrates the way in which the gray or stipple pattern of the platyfish is inherited. In the pair on the left, the father carries the dominant factor (StSt) for stippling while the mother is non stippled (stst). The parents are designated as P1. The first filial generation (F1), obtained from this mating, are all stippled (Ststst) like their father. Similar results are obtained when the mother (see pair on right) is the stippled parent (StSt) and the father is non stippled. The offspring of this mating are also all stippled, this time like their mother (Ststst). When the individuals of the first generation (F1) are bred together from either series, and the second generation (F2) is produced. the following results are obtained: there are three stippled fishes (*StSt*) or (*Ststst*) to every non stippled one (*ststst*). There are male and female representatives in each group. This is an example of simple mendelian inheritance of a single heritable character. The stippling is actually due to the presence in the skin of very small black cells, technically known as micromelanophores.



This diagram illustrates the peculiar way in which the spotted (Sp) pattern is inherited. The female is represented by the formula W Z while the male is Z Z. The spotted factor is associated with sex. When the spotted platy is the male parent (Zsp Zsp) and a non spotted platy is the female parent Wsp Zsp), all the offspring of the mating, both the sons and daughters, are spotted like their father. When the spotted individuals of the first generation (F1) are mated together, brother to sister, the ratio of three spotted platyfishes to one non spotted is obtained in the second generation (F2). Up to this point the results of this mating resemble the inheritance of the stippling factor, but note the following significant fact: all the non spotted fishes obtained in the second generation are *females*. And the spotted platyfishes contain both males and females, but there are two spotted sons to every non spotted daughter. This is an example of the inheritance of a sex-linked heritable factor. A similar type of inheritance is found in birds and moths for certain characters.

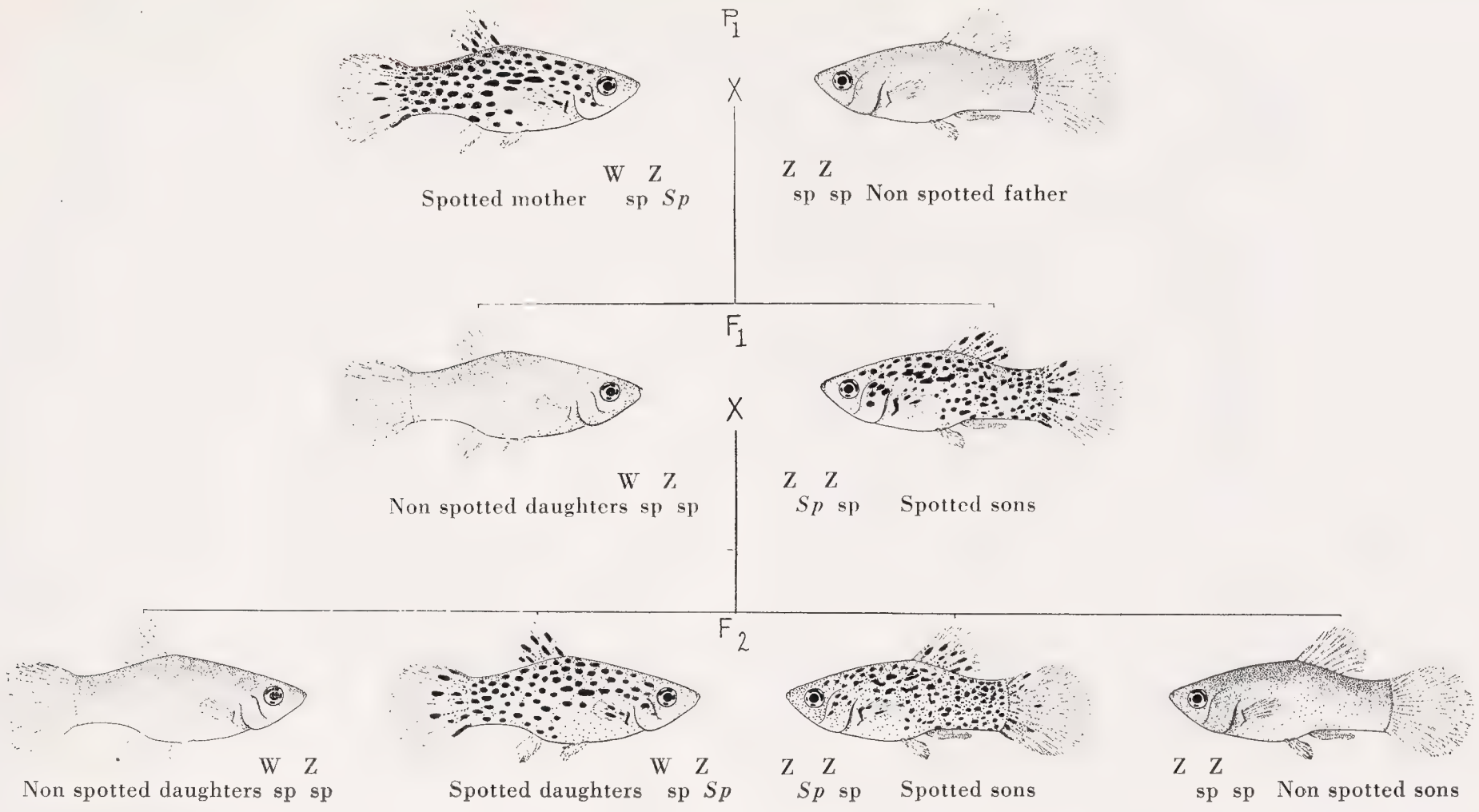
body, until they are hatched; and then finally we have the viviparous fishes like the guppyies and platyies where fertilization is internal and the young, after a period of gestation within the mother's body, are born alive.

Many phases of the life process are still shrouded in mystery. By what mechanism are the sex or germ cells endowed which enable them to recreate the species from which they spring? While the body cells eventually die of old age, the germ cells, produced before death, bridge the stream of life and new individuals of the race appear, generation after generation. This reproductive power of the germ cells virtually amounts to immortality.

The history of germ cell development in animals has for the past fifty years been a fertile field for investigation. More than five hundred papers have been published on the subject, yet the story is far from complete. It was thought at one time that after the fertilization of the egg by the sperm, the immediate cellular divisions separated the newly formed cells into two kinds: the germ cells which were to be used in further reproduction and, the body or somatic cells which were to build the body proper. Some looked upon the body as merely a vehicle in which the immortal germ cells resided, temporarily. Conditions, as simple as those just mentioned, are found only in comparatively few animals.

In a recent study of the history of the germ cells in the Mexican platyfish, *Platypoecilus maculatus,* Wolf finds that the primordial germ cells arise from embryonic tissues, technically known as the lateral mesoderm. But this material also produces most of the body cells. There is no sharp division in the beginning of germ and soma. The old question still remains, how do certain cells of the lateral mesoderm become endowed with the function of reproduction?

The history of the male sex elements on sperms, after the primordial germ cells are separated off from the rest, is described by Jean Vaupel for the common aquarium fish, *Lebistes reticulatus.* In this process, which is known as spermatogenesis, there is an intricate plan in force which transforms the primitive, globular, immobile, germ cells into highly specialized, elongate and active cells. Each sperma-



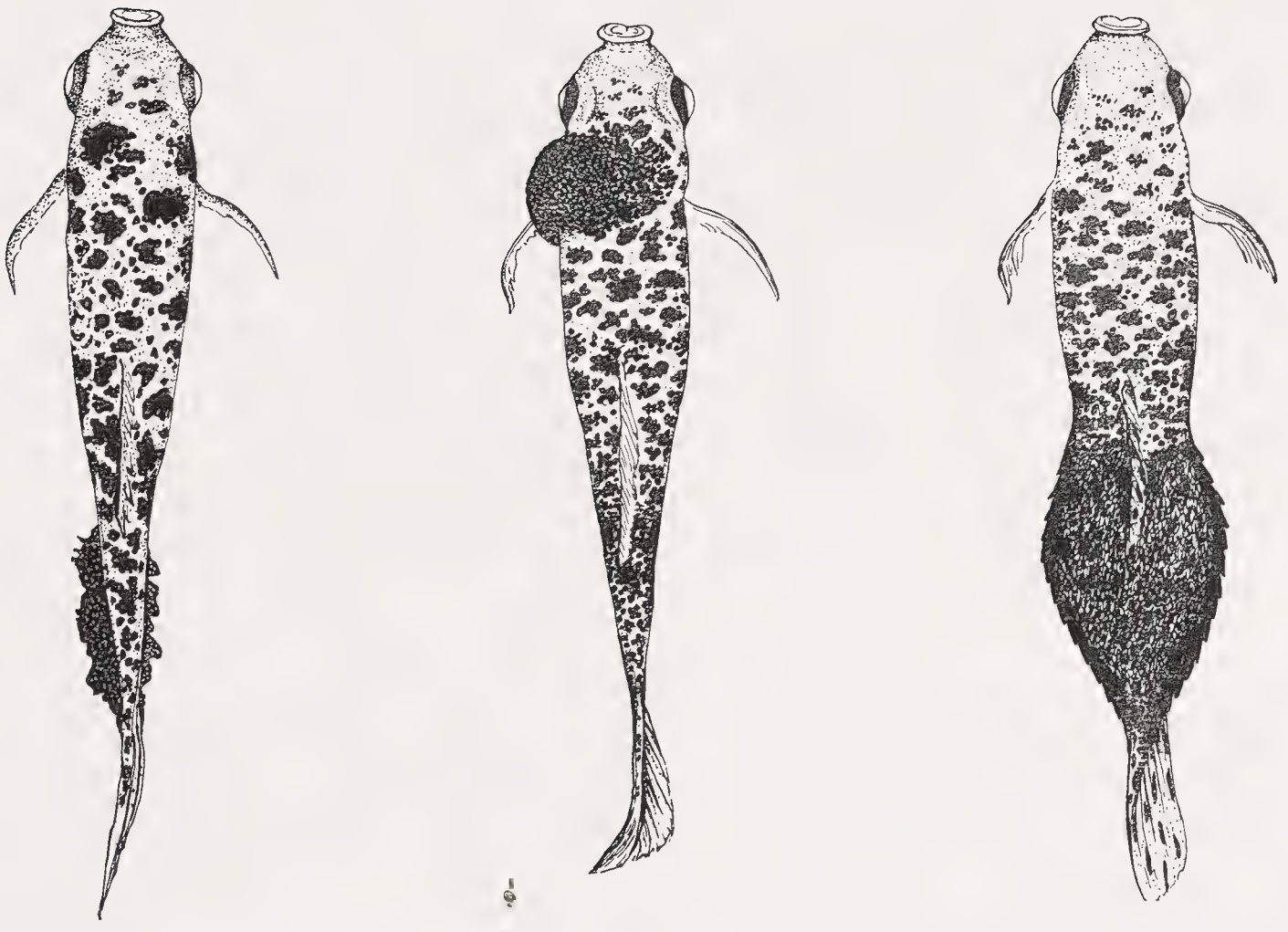
This diagram illustrates the reciprocal type of cross to the one shown on the opposite page. Here the female parent, W Z, is the one which is spotted, while the father, Z Z, is non-spotted. The results of this mating are different from those obtained on the opposite page, as follows: It is found that the spotted factor passes to the sons only, Z Z; the daughters have not inherited the dominant factor for spots, W Z. It will be seen that the heritable character, spots, has criss-crossed from the mother to her sons. When the spotted sons are mated to their non-spotted sisters, the following results are obtained in the second generation, F2: there are just as many spotted platyfishes as non-spotted ones. This is a 1:1 raio, and not the usual 3:1. These results differ also from those diagrammed on the opposite page, in that here both male and female representatives are found not only in the spotted group but also in the non-spotted one.

tozoön is equipped with a long lash which propels it through the water. It swims to its final destination, the ripe egg within the ovarian sac of the female. According to Winge, sperms may live for six months within the body of the female and retain their virility.

We are accustomed to think of the higher animals as being male or female, although there are authentic, but rare, cases of hermaphroditism. This situation is also true of fishes. In this connection the case of sex reversal in an aquarium fish is interesting. Essenberg, then working in the University of Oklahoma, studied the development of germ cells in the Mexican swordtail, *Xiphophorus hellerii.* He has described a female, the mother of several broods of young which, after its third year (nearing old age), ceased producing young. This in itself is nothing peculiar but note what follows. It began to take on the characteristics of a male and developed a small sword. Changes also began to take place in the anal fin toward the transformation of that fin into a gonopodium, the intromittent organ. Finally, Essenberg in Oklahoma and Harms in Germany have succeeded in getting sex reversed female swordtails, acting as males, to mate with normal females. And the latter actually produced young.

The full significance of sex reversal in vertebrate animals can only be learned by further work. The study of sex development in tropical fishes is bound to throw more light on the problem of sex determination which, for generations, has been a matter for speculation. It is obvious that for accurate work along these lines the full life history of the animals must be known. Tropical aquarium fishes, with their rapid rate of development and their comparatively short life cycle are, in care of competent hands, excellent experimental animals for the biologist who is particularly interested in these important problems.

The work of students of embryology need not be seasonal and depend upon natural periods of breeding of native fishes. A survey of the available aquarium species will surprise them with the abundance and variety of the available material. Eggs of tropical aquarium fishes may be obtained for study throughout the year under aquarium conditions. Development is rapid. For example, the eggs of the paradise fish, *Macropodus opercularis,* hatch in three days at an average temperature of 80°F.

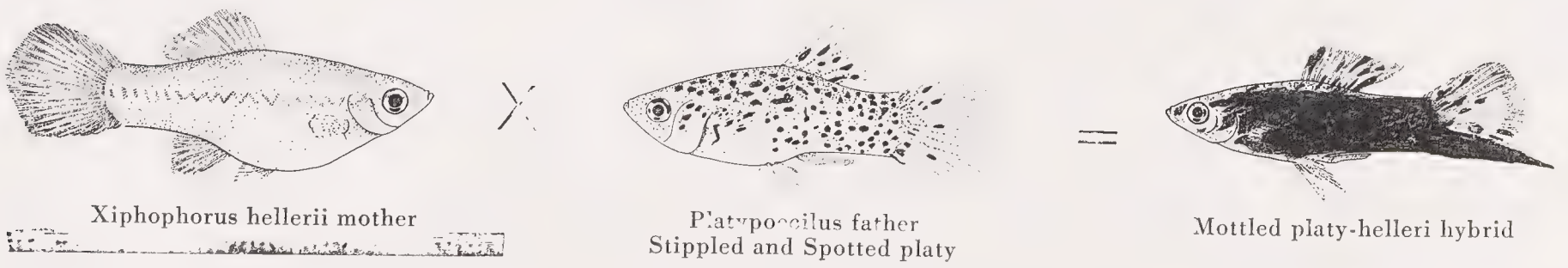


These three fishes show distinct tumors. They are the product of the mating of a spotted platyfish and a Mexican swordtail. Experts in cancer researches, upon microscopic examination of these specimens, confirm the statement that these fishes show advanced stages of a true neoplastic disease, technically known as melanosis.

Xiphophorus hellerii mother — Platypoecilus father, Gold platy — Red-finned platy-helleri hybrid

Xiphophorus hellerii mother — Platypoecilus father, Red platy — Red platy-helleri hybrid

Xiphophorus hellerii mother — Platypoecilus father, Black platy — Black platy-helleri hybrid



Xiphophorus hellerii mother — Platypoecilus father, Stippled and Spotted platy — Mottled platy-helleri hybrid

The platyfishes and the Mexican swordtail will readily hybridize. The hybrids are classified according to the original varieties of the species used in the cross. The gold platy and the swordtail produce the red finned platy-helleri hybrid. The red platy and the swordtail produce the red platy-helleri hybrid. The black platy and the swordtail produce the black platy-helleri hybrid. The stippled and spotted platy and the swordtail produce the mottled platy-helleri hybrid. These hybrids frequently develop the neoplastic disease known as melanosis. A few of the fishes with tumors are shown in another diagram.

Examples in Heredity

Some of the interesting facts of heredity, brought out from work with tropical aquarium fishes, may be conveyed to the reader by a series of diagrams. The work which is figured is taken chiefly from the genetical papers of Fraser and Gordon who have worked with the Mexican platyfish and swordtail.

Three examples of inheritance will be illustrated: first, simple mendelian inheritance of a single character; second, the inheritance of a character associated with sex (this involves information which is helpful in predicting the sex of the animal long before external sexual differentation takes place); and third, the inheritance of factors influencing the development of melanosis, the neoplastic disease which attacks certain hybrid fishes. (Melanosis is a cancer-like disease characterized by the formation of large black tumors in the skin of hybrid fishes. The fishes involved are the spotted varieties of Platypoecilus, the platyfish, and Xiphophorus, the swordtail).

Cancer Research

With respect to the work on tumor development in fishes, we have evidence which shows that this disease has a definite hereditary basis, but the complete, detailed analysis of the problem has not been finished. Our present stand in this matter is comparable to that of a chemist to whom a complex substance is given for analysis. After a few experiments the chemist may be ready to name the more important elements which the substance contains; but a complete, detailed, qualitative and quantitative, analysis must be made for determining all the constituents of the material.

Work on the neoplastic disease of tropical fish hybrids is receiving the attention not only of professional ichthyologists but also of medical men. No one knows where the next positive advance will come in cancer research. It is the hope of the investigators at Cornell University, where the work is being done in this country (and I am sure of Kosswig and Haüssler in Germany) that they will find new information which will be of value in solving the difficult problem of cancer development.

Note: The following two papers contain references for those readers who desire to go further into the problems mentioned in this discussion:

H. B. Goodrich, Mendelian inheritance in fish, Quarterly Review of Biology, Vol. IV, No. 1, 1929, Baltimore.

Myron Gordon, The hereditary basis for melanosis in hybrid fishes, The American Journal of Cancer, Vol. XV, No. 2, 1931, New York.

The Family Life of Certain Small Fishes

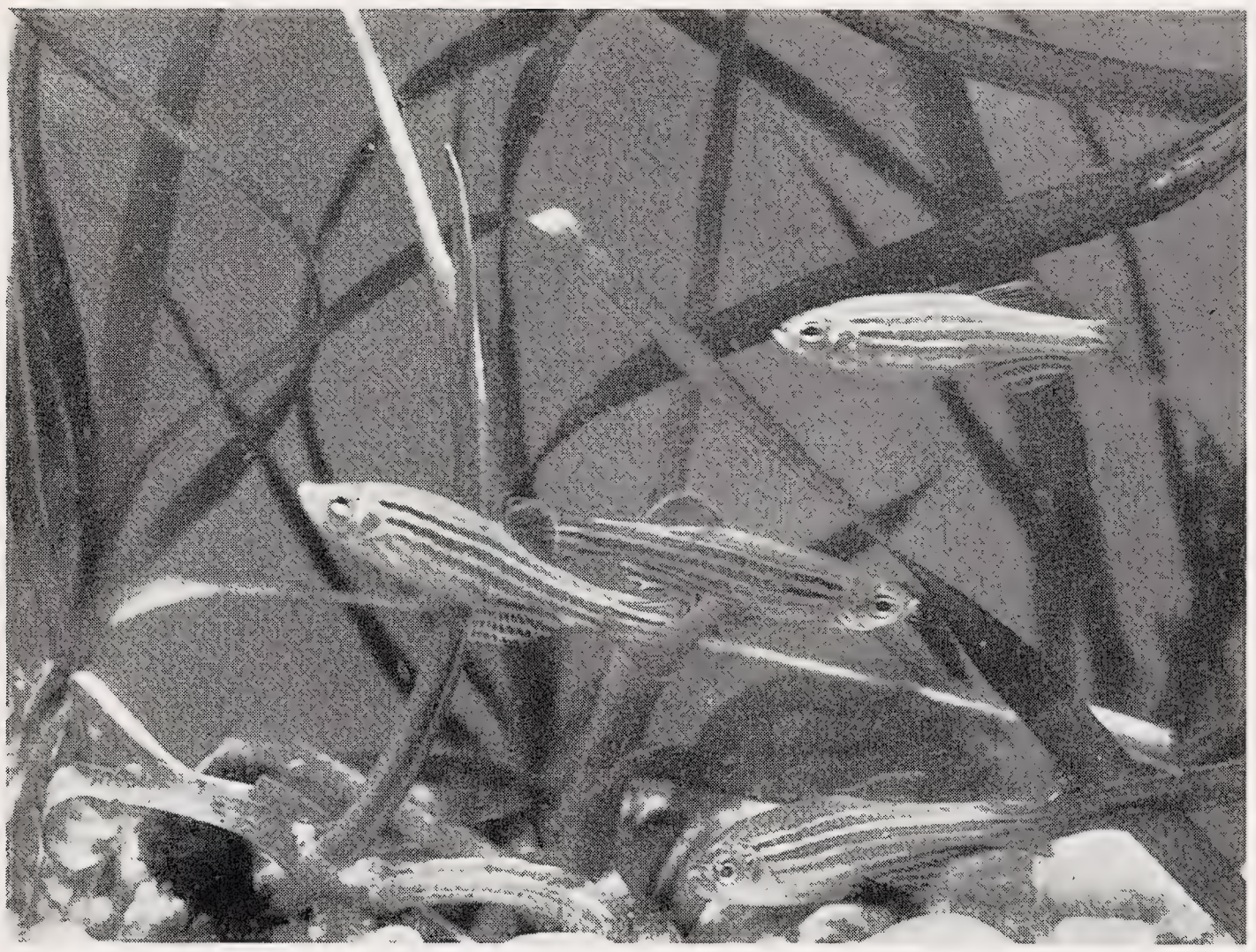
C. W. Coates

No matter how familiar, or how blase, an aquarist becomes with his charges, it is a never ceasing source of wonderment how, under the most adverse conditions, certain fishes persist in fulfilling their destiny by raising and caring for a family of young.

Some of the most popular aquarium fishes bring forth active young, and it is a comparatively simple matter for them to give birth to a family in spite of almost any difficulty, except, of course, in those cases where life itself is impossible. Such fishes almost invariably cast their fry forth to fend for themselves and, if the parent fish are improperly fed, the babies run the greatest risk of being eaten by their progenitors. These fishes, however, are very prolific and seemingly hardy, and there is generally an abundance of them wherever they are found.

Then there are those fishes which strew their eggs freely throughout their habitat, letting them fall where they will, and giving absolutely no attention to them. These fishes are just as ready to eat their eggs as any other fish or animal that may happen along. Indeed, some of the fishes in this category, notably the *Danios,* which cast their eggs loosely over a pebbly stream bed, have even developed a technique for arriving at those eggs which have fallen out of reach among the stones. They will swim over the crevices in which the eggs are lying and, giving a peculiar twist with their tails, cause an upward flowing stream of water to bring the eggs within their reach. Such fishes are also very prolific, spawning hundreds of eggs at a time, of which a very small percentage achieve maturity.

Broad-headed cichlid, *Aequidens latifrons*. A brightly colored species that breeds well in aquaria. Its reproductive habits resemble those of the North American sunfishes. Male left. Female right. Photograph by S. C. Dunton.



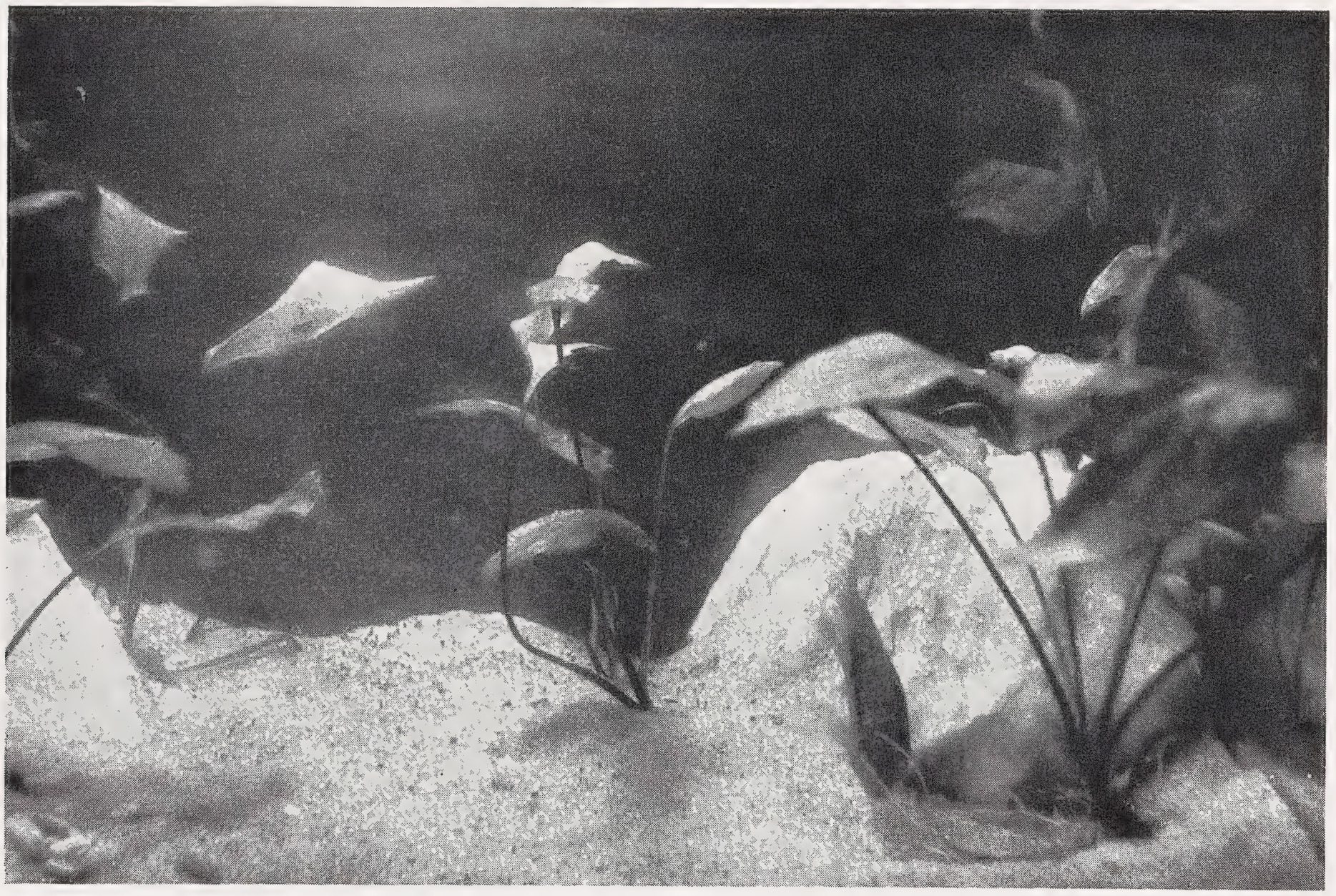
Zebra danio, *Brachydanio rerio*. A popular and prettily marked fish. The pattern is chiefly one of horizontal stripes of blue and silver. Photograph by S. C. Dunton.

Other fishes, however, build nests of one sort or another, into which they deposit their eggs. Most of these species are very careful to allow nothing to interfere with the developing spawn, and become quite ferocious at this time. Elsewhere in this volume is a photograph of a female jewel fish (*Hemichromis bimaculatus*) attempting to bite a man's finger which was too near the stone where she had deposited her eggs. Absurd as it appears, it will give some indication of the utter fearlessness and savagery of these tiny animals when engaged in incubating their ova. In this group are the Cichlids, not at any time a peacable family, and during the nesting and rearing season quite fierce and unapproachable.

In Battery Park a pair of these, Broad-headed Cichlids (*Aequidens latifrons*) mated in an aquarium in which were other savage, and in some cases larger, fishes and the process was interesting in the extreme. The mated pair, two of several of the same species, picked a corner of the sandy bottom of the tank and cleared it of all the debris and some of the sand, thus making a clear depression. Into this they spawned, and then their difficulties began. The other fishes in the tank would have snapped up each egg as a delicious morsel, had not the Cichlids kept them away. They worked out their problem very well.

One of the fish stood guard over the nest, keeping it free of the miscellaneous matter always present in a standing body of water, while the other shepherded all of the other fishes to the distant end of the aquarium. Usually the male did this while the female watched the nest. At feeding time the male would dash into the milling swarm of fishes congregated about the falling food, snatch a few mouthfuls—always keeping a wary eye on the manoeuvering of

Pearl danio, *Brachydanio albolineatus*. A relative of the Zebra danio, the color of which is that of mother-of-pearl. Photograph by S. C. Dunton.



The male of the broad-headed cichlid gathering up the more adventurous of his offspring. The small dark dots to the left of the center at the back of the aquarium are young fishes. It is in this general area that the male is trying to keep his charges. Photograph by S. C. Dunton.

the other fishes, ready to drive away any that appeared unduly interested in his nest—and then swim over to the nest to relieve the female of her nursery duties. Immediately upon his arrival, but not an instant before, she would hurry over to the feeding place and, while snapping up some food, ably perform the policing duties of her consort. After a few mouthfuls she would return to the nest, and the male would come back for more food. This interchange of duties would occur as many as three times before the hunger of either was appeased. Then the female always returned to the nest. Occasionally the male and female would exchange duties for a short period for no apparent reason, unless it was to give the female a chance to exercise herself. At no time was the nest unguarded, and likewise at no time were the other inhabitants of the tank free to go where they pleased. They were all herded into the end of the tank farthest from the nest; unmolested if they did not wander, but unceremoniously hustled back if they did. After hatching, the fry remained in the nest for a few days and then ventured forth in a school. At this time the vigilance and activity of the parent fish were redoubled, each keeping the babies in one school, and each attacking any venturesome fish which attempted to investigate the interesting goings-on at the opposite end of the tank. At feeding time the same procedure as before was followed, differing only in that the babies were conducted back to the nest until the excitement of meal time was over. The school of fry never were allowed far from the nest at this time, but as they grew older they tried to exercise their strengthening muscles farther afield, only to be brought back each time. The parent fish with them would, at intervals, throw up a mouthful of the sediment from the bottom of the tank, making a muddy cloud into which the fry would disappear, probably seeking the animalcules to be found in it.

As the fry grew older, they were allowed to swim more freely but at the slightest disturbance, such as a tapping on the glass walls of the tank, they would immediately dart to the side of the parent fish, when it would lead them back to the nest until all was quiet again. An effort was made to find out if either of the

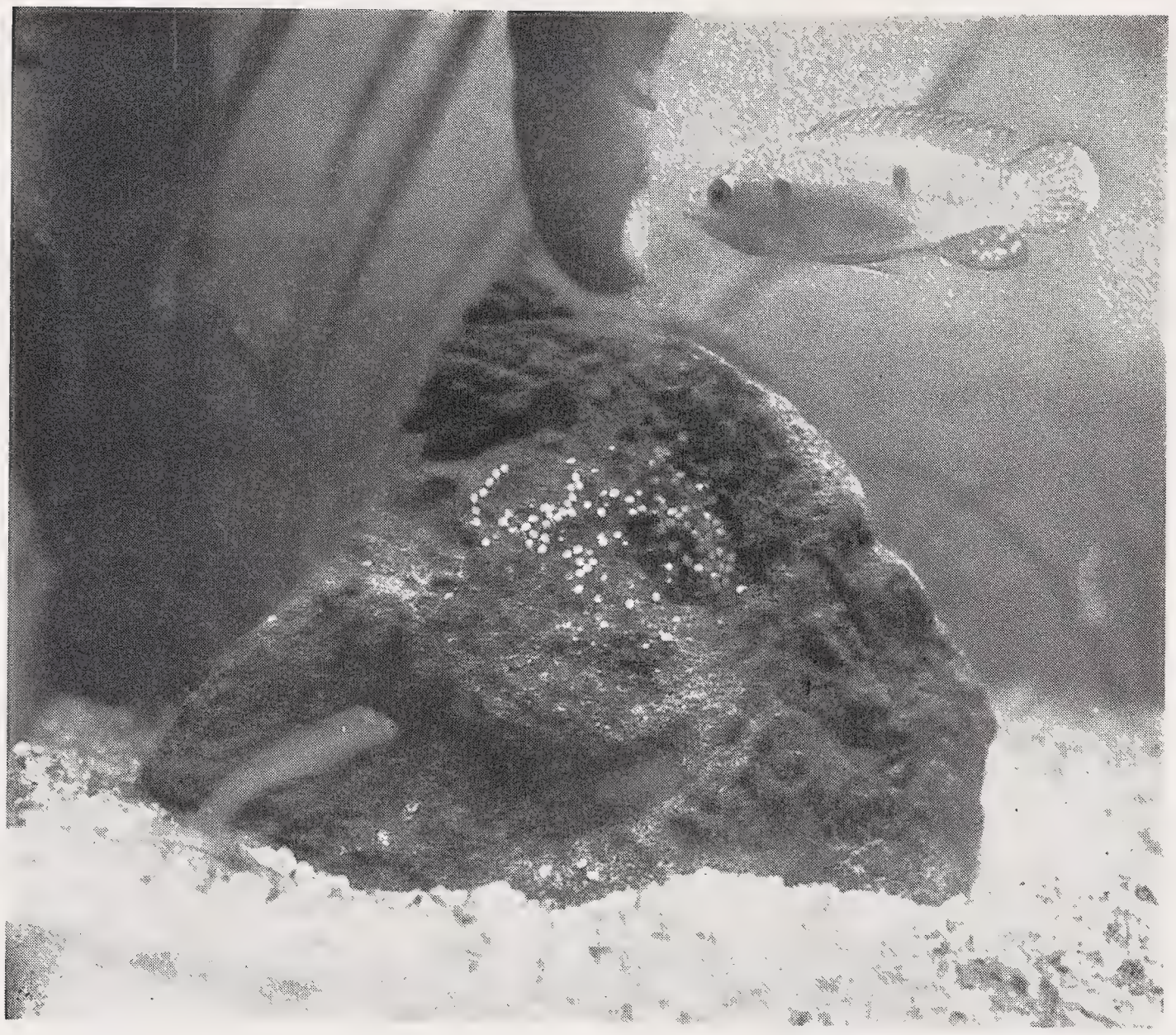
parents gave any sign as to which one the babies were to return to.

This was tried by having the disturbances caused when both the female and male were in charge of the fry, so that they might easily have become confused, but they always went back to the fish at the moment doing nursery duty, although sometimes the other would be nearer to them. A pretty problem in the mental life of fishes is inherent in this behavior.

After the fry had become bolder and ventured further afield, where they were in real danger of making a meal for the other fishes, in spite of the efforts of the parents, all the mature fishes were removed from this tank as it was desired to bring the fry to maturity.

The reasons for such care as the Broad-headed Cichlid bestows upon its nest and young are obscure, inasmuch as there are other fishes which will build nests, sometimes caring for the developing ova and sometimes not, in approximately the same circumstances, and whose young are apparently just as helpless as are the young of these cichlids. They may be even more so, for while the development of the species described is comparatively rapid, the growth of the young of the Paradise fish, the Siamese fighting fish and other members of the Osphromenidae is very slow. The two fishes just mentioned are good examples of the initial care and frequent later abandonment of the nest and young, with no apparent disastrous effects. The males of both species build elaborate nests of air bubbles, surrounded and cemented together by a buccal secretion, into which the fertilized eggs are carefully placed by the males. The female will also do this if allowed by her mate, but he drives her off until ready for further spawning when he displays his colors and fins to reattract her beneath the nest. After the spawning is completed he drives her off completely, as he will any other fish that comes too close, unless it happens to be a female, when he not infrequently abandons the first nest and builds a new one for the accommodation of the eggs of the second female. When his spawning is over, he stays under the last completed nest, picking up and replacing eggs which have fallen out, and keeping the fry in the nest as they hatch out, until they evade him by sheer weight of numbers, when he is just as likely to eat them.

The young of the broad-headed cichlid of the size at which they get out of parental control.
Photograph by S. C. Dunton.



Ruby jewelfish, *Hemichromis bimaculatus*. This fish, with its hatch of eggs stuck to a rock, is shown attacking an intruding finger. Photograph by S. C. Dunton.

It has been thought that this care of the eggs and nest had to do with the number of eggs spawned; that is, that those fishes which strewed large numbers of eggs about carelessly completely abandon them, while those fishes which had few eggs cared for them. This supposition upon closer scrutiny is greatly modified by a number of other factors not always clear in aquaria. It has been computed that a Danio (*Brachydanio rerio*), one of the freely spawning Cyprinidae, not to mention fishes of groups not suitable for observation in a small aquarium, will spawn about five hundred eggs twice a year for two years, making a total of two thousand eggs per male and female. The apparent survivors are evidently not more than two, since the total of the species does not perceptably increase. The Broad-headed Cichlid, whose spawning behavior was previously described, deposits an estimated five hundred eggs at least twice a year, and possibly oftener, for three or four years, taking care of each batch of young but without any increase of numbers either. At least it is fair to assume that there is none else their native waters would soon become a solid mass of fish.

It is somewhat difficult to generalize from such facts as are arrived at from observation of fishes in aquaria, for while each aquarium must of necessity be, to some extent, a reproduction of the native waters of the inhabitant or it will not live, it is oftener an imitation from which everything harmful has been excluded. This in turn causes modifications of the habits of its inhabitants to appear. Then, too, there are considerable differences in behavior between two individuals of the same species.

Although the fishes under observation, in general, have not the capacity to vary very much from their norm in order to accommodate themselves to conditions that are very different, they will continue such habits as are peculiar to their species through an indefinite number of generations, even when the cause for such peculiarity has been removed. As an instance, the Splashing salmlet (*Copeina arnoldi*), for some undiscovered reason was probably forced to deposit its eggs above the water on overhanging leaves, keeping the eggs wet by beating up the water with its tail and splashing it over them. In an aquarium, where there are apparently none of the original causes for such behavior, the fish still continues the habit, using the glass walls of the aquarium in place of vegetation.

Therefore, while it is certainly not correct to assume that all fishes of a given species do exactly as such few of their number as have been observed, it is still quite reasonable to assume that their behavior in the aquarium, if successful, is not very remote from that to be expected in a state of nature.

Flying characins, *Gasteropelecus sternicla* (silvery) and *Carnegiella strigata* (mottled). These fishes actually fly for short distances. The large and peculiarly formed ventral region is nearly entirely devoted to pectoral (wing) muscle. Photograph by S. C. Dunton.

The sources of the Aquarium's collection of fishes. The spots on this world map indicate localities from which fishes now living in the New York Aquarium have come. Each spot represents from one to one hundred species. Drawn by K. McDermott.

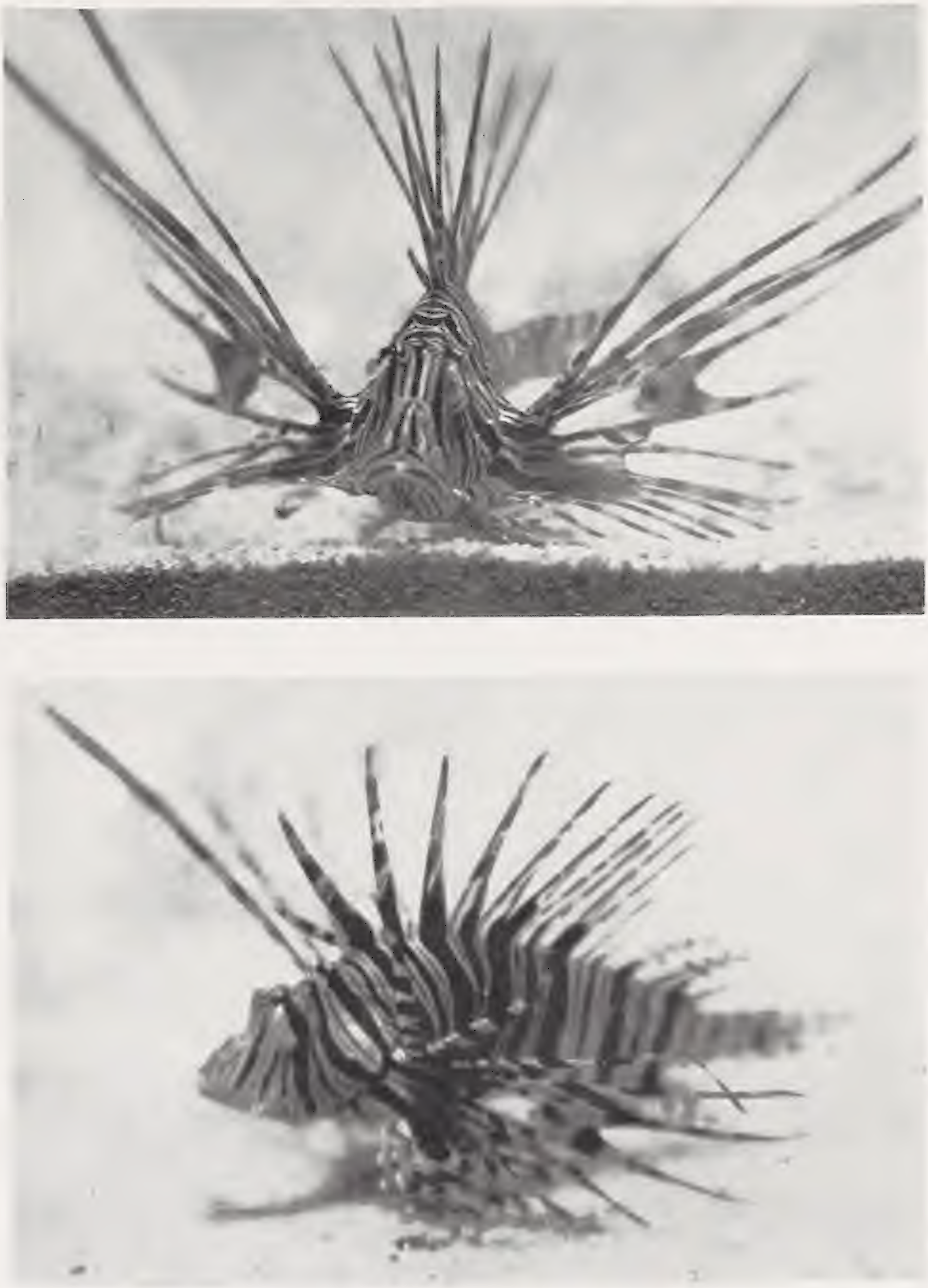
Guppy, *Lebistes reticulatus*. Probably the best known small aquarium fish. Extremely prolific. Originally native to Venezuela and Trinidad. Now widely distributed. Photograph by S. C. Dunton.

Mud springer, *Periopthalmus koelreuteri.* Probably the most nearly terrestrial of all true fishes. They spend much time sitting with the eyes out of water, frog fashion, as shown in the upper picture, or in stalking insects out of water as shown in the others. Photograph by S. C. Dunton.

A typical balanced aquarium of the new department. The fish are crescent fish, *Pterophyllum scalare*. Photograph by S. C. Dunton.

Climbing perch, *Anabas scandens*. A dull colored fish of interest chiefly because of its ability to live out of water and navigate over land. This ability has been somewhat over-emphasized, but it is nevertheless true that it can get about on land with a surprising degree of success. Photograph by S. C. Dunton.

The Piranha, *Serrasalmo rhombeus*. One of the smaller of the "man-eating piranhas." Note the smooth knife-like scallops in the piece of meat on which they have been feeding. This species is related to the fish made famous by Theodore Roosevelt on his "River of Doubt" expedition. Photograph by S. C. Dunton.



Zebra fish, *Pterois volitans,* of the Indian Ocean. A remarkably exaggerated type of scorpion fish. Photograph by S. C. Dunton.

An Interesting Scorpion Fish

SCORPION fishes as a group are all more or less bizarre creatures, large of head and variously ornamented with spines, tabs of skin, and patterned in unusual fashions. For most part they rest quietly on the bottom and snap up unsuspecting small fishes or other animals that venture close to their rapacious mouths.

The Aquarium was most fortunate in obtaining what is probably the most fantastic of all of them, in the form of the Zebrafish *Pterois volitans* of the Indian Ocean. This specimen, about eight inches long and variously striped in vivid black and white, is well illustrated in the accompanying photographs. The spines and rays of the dorsal and pectoral fins are greatly produced, reaching far beyond the membranes connecting them. In most fishes these membranes reach to, or nearly to, the tips of these supports which together make up the fins.

More striking than the physical appearance of this fish is its behavior toward food. The two smaller illustrations show it in "profile" and "full face" as seen resting, typically, on the floor of its tank. Under no stimulation it would rest for hours, as shown. The introduction of a small food object would invariably cause an immediate but scarcely noticeable reaction. In a slow stately manner the fin rays would be wig-wagged back and forth. In the "head-on" view those of the dorsal fin are seen to not be in line. It is in such a fashion that these spines would be moved, not in unison, but progressively, like the legs of a centipede, but with extreme deliberation. This would continue until a small fish would come to investigate, possibly visualizing only weedy shreds swaying in the current in which might be lurking still smaller food objects. Nothing further would happen until the small fish chanced to stray to exactly the proper position in front of this camouflaged monster. A single motion and all was over. This act was always done with almost unbelievable rapidity and never with a miss, so far as our observations were concerned at least. The meal would be gulped down and the process repeated until hunger was appeased. Then the beckoning rays would cease to weave to and fro, and quiet in the tank was resumed.

The most interesting phenomenon did not occur until the Zebrafish had been a resident in the Aquarium for some months. After it became more or less "acquainted with," and somewhat a pet of its attendant, it took to drifting about, free of the bottom, with all fins spread as shown in the larger photograph. It would drift toward the surface awaiting its turn to be fed, tilting over in order to glance upward in a most un-Scorpionfish-like attitude. It no longer was content to rest on the bottom and wait for dinner to arrive under its own power. Instead, it would drift imperceptibly toward a small fish, with the long rays waving as previously described. It is well illustrated in a very typical pose in the photograph including the food object. Now the most remarkable action of all would take place. This was not on the part of the Zebrafish but on the part of its food. Instead of moving off as these small killies always do on the approach of a large and strange fish, there seemed to be some mutual attraction between the two for which we can give no satisfactory explanation. A bare description of the observable facts will have to suffice, for the present at least.

When in about the position shown, the food fish would begin to wave from side to side in a rapid almost palsied manner. This would continue until the two were not more than an inch apart, when with a sudden gulp the smaller would start on its journey to become part of the larger. Our men were somewhat disposed to argue that a form of hypnotism was involved which, of course, is reminiscent of the ever current snake stories with a similar ending. Be that as it may, it is never-the-less true that the smaller and more agile fish could have eluded the Zebrafish with little effort, and it is doubtful if it could have systematically caught killies by ordinary pursuit in quantities sufficient to keep it alive. Other fishes, of even better streamline form, are often utterly unable to catch such active and agile small forms. The only other times we have seen killies shake in quite the manner described has been when near death, due to certain parasitic diseases.

These two causes seem to have little in common, except that they result in the subject making superfically similar muscular motions. The movement toward the approaching Zebrafish, and this curious shaking, can be explained on no reasonable basis that we are aware of at the present time. —*C. M. Breder.*

Zebra fish investigating a killie. See text for description of this very complicated behavior. Photograph by S. C. Dunton.

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Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

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Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee of the Society.

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New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

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Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Technical and generally taxonomic description. Volumes I, II, III, IV, V, VI and VIII completed. Other volumes in preparation. Irregular. Issued as subjects are presented. Illustrated.

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Bulletin: Official publication of the New York Zoological Society; devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-four volumes completed. Volume XXXV in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the collection of Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Publication temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. 21 editions issued. Published as needed.

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For all publications, other than those referring to the Aquarium or Aquatic Life—address: H. R. Mitchell, *Manager, 185th St. and Southern Boulevard, New York City.*

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Sea Shore Life (Mayor); 181 pp. 119 ills. Out of print. To be re-issued.
Cultivations of Fishes (Townsend); 27 pp. 17 ills.
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For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Manager, Zoological Park, 185th St. and Southern Boulevard, New York City.*

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Vol. XXXV, No. 2

Contents

March-April, 1932

DEEP-SEA GOURMAND ..... *Frontispiece*
LABORATORY—DEPARTMENT TROPICAL RESEARCH ..... *W. Reid Blair* 35
THE WORLD OF BERMUDA FISH ..... *William Beebe* 36
COLOR-CHANGES IN BLUE-HEAD WRASSE ..... *John Tee-Van* 43
ULTRA-VIOLET RADIATION ..... *Gloria Hollister* 49
RECENT ARRIVALS—ZOOLOGICAL PARK ..... *E. R. Osterndorff* 51
BOWER-BIRDS AND THEIR BOWERS ..... *Charles Barrett* 55
ZOOLOGICAL PARK BOWER-BIRDS ..... *Lee S. Crandall* 65

Illustrations

DEPARTMENT TROPICAL RESEARCH

Bermuda Home
Lantern-fish
Gulper Eel
Deep-sea Pebbles
Laboratory Zoological Park
Laboratory Interior
Laboratory Staff
Blue-head Wrasse
Experiment in Irradiation

RECENT ARRIVALS—ZOOLOGICAL PARK

Whooping Swan
Milky Eagle Owl
White-tailed Deer
Chimpanzee
Sand Grouse
Nine-banded Armadillo
Dalmation Pelican
Capybara
European Hedgehog

BOWER-BIRDS AND THEIR BOWERS

Australian Homestead
Satin Bower-bird and Bower
Twigs "painted" by Satin Bower-bird
Site of Satin Bower-bird's bower
Regent Bird's Haunt
Bower of Satin Bower-bird
Fawn-breasted Bower-bird
Bower of Fawn-breasted Bower-bird
Satin Bower-bird—Immature

FAWN-BREASTED BOWER-BIRD ..... *E. R. Osterndorff* *Cover*

BULLETIN

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Editorial and Subscription Offices, Zoological Park, New York City, Elwin R. Sanborn, Editor.

A deep-sea gourmand, *Chiasmodon niger* Johnson

Top. Normal fish with empty stomach. *Upper left*. After a meal of thirty-one larval lantern-fish. *Upper right*. Having dined off a huge squid. *Lower left*. What would seem a week's ration, after consuming a Unicorn fish (*Bregmaceros*). The latter, which is shown below, is more than twice as long as the Gourmand. From a water-color drawing by Else Bostelmann.

BULLETIN
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The New Laboratory for the Department of Tropical Research

EVER since the establishment of the Department of Tropical Research, under the direction of Dr. William Beebe, it has been realized that the time would come when a substantial working laboratory, library, and adequate storage facilities would have to be provided in the Zoological Park for this department.

The valuable collection of specimens obtained by Dr. Beebe and his staff during various expeditions has now reached such importance that in order to make this material readily accessible for careful study purposes a building in the Zoological Park has been completely remodelled and the department's collections installed during the past winter.

The location of the laboratory, which is situated immediately south of the Aquatic Bird House, affords the necessary isolation essential to the carrying on of research work without interruption or invasion by visitors.

The building is a substantial one-story brick building with adequate daylight provisions and fully equipped with electric lights throughout.

The main laboratory room is thirty-six feet long and twenty-six feet wide and is fitted with metal shelves and glass containers which make the specimens readily accessible for gross examination.

The library and record room is twenty-five feet by sixteen feet and affords ample room for expansion. Two rooms about ten feet square are also available for laboratory and storage facilities.

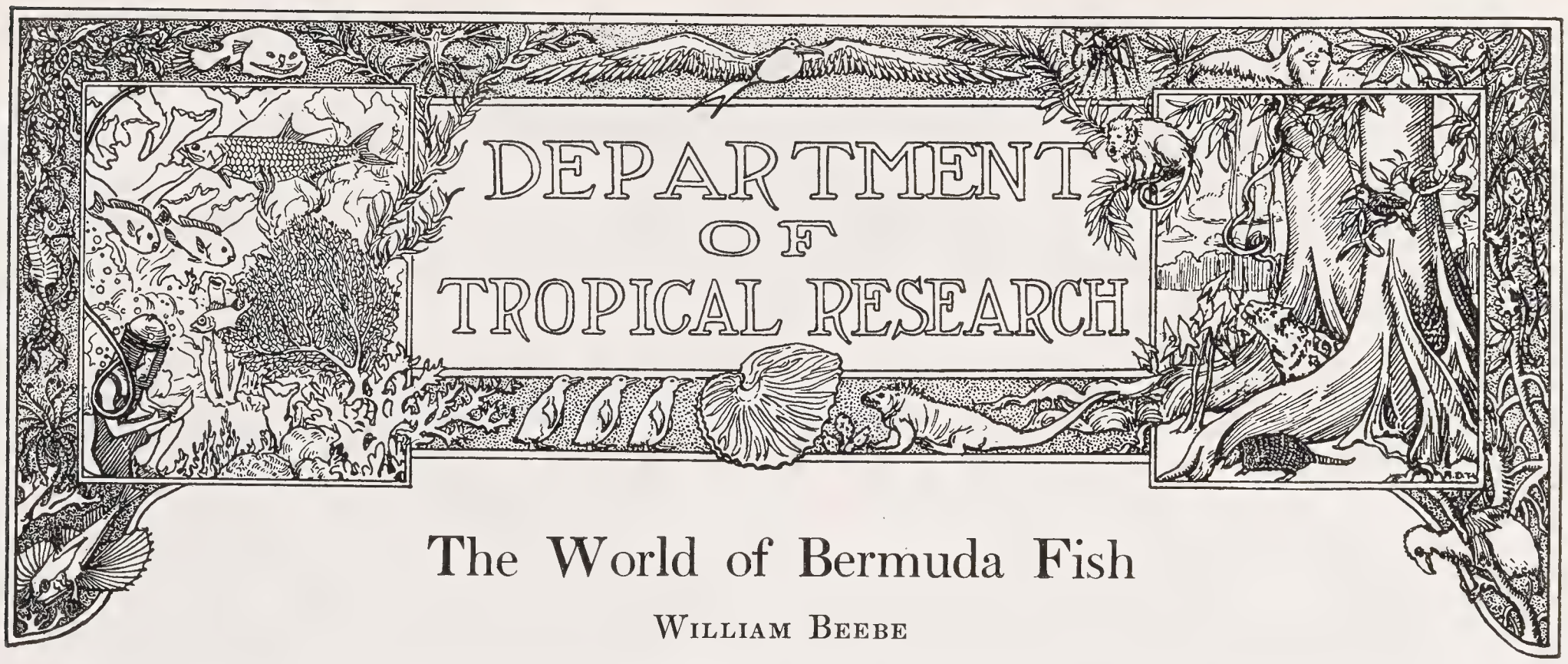
The collections already installed in the new laboratory include all the specimens taken during the British Guiana, the *Noma*, *Arcturus*, Haitian and Bermuda Expeditions, as well as the paintings and drawings made during these expeditions.

During the past winter the staff has been engaged in the identification and study of the deep-sea specimens taken on the Bermuda and *Arcturus* Expeditions, and in the study of the shore fishes of Bermuda with a view to the preparation for publication of a "Handbook of the Shore Fishes of Bermuda" as well as other papers on the same group of fishes. Miss Hollister is continuing her research on the skeletal features of fishes by means of chemical clearing methods.

The value of such a rich collection of scientific material can only be secured through precise zoological classification and study of the specimens taken on the various expeditions.

Much of the work now being done in the laboratory consists of sorting and preparing for shipment to experts in other institutions many of the invertebrate specimens which have not as yet been described.

In this way valuable additions to scientific knowledge will be obtained and bring added prestige to the Zoological Society. *W. R. B.*



The World of Bermuda Fish

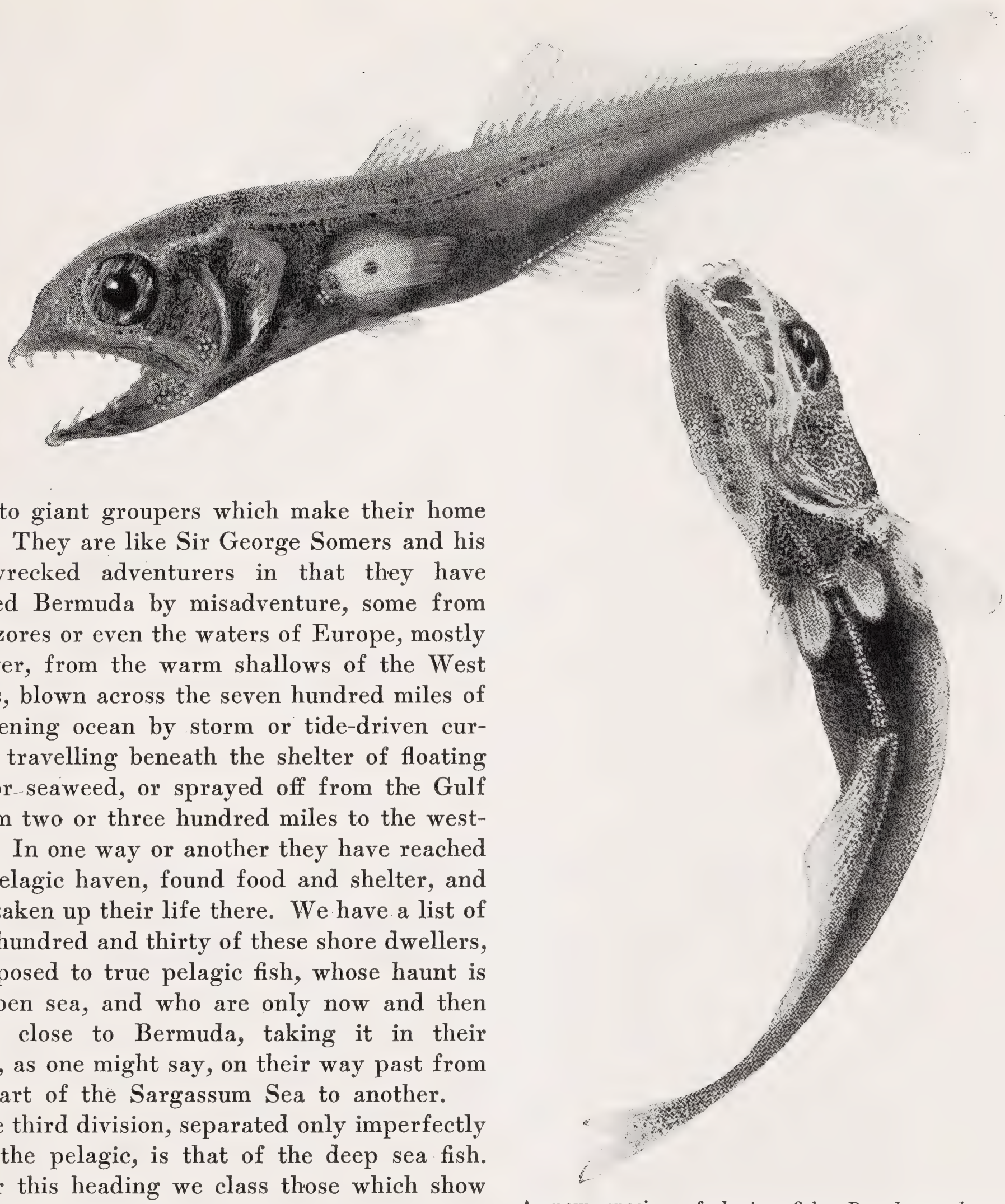
William Beebe

Illustrations from photographs and water-color drawings by the Staff, and also photographs made in the Zoological Park by E. R. Osterndorff.

LITTLE by little the members of the Zoological Society's staff of the Department of Tropical Research are getting a more comprehensive grasp of the big problems they have undertaken in Bermuda. There are two of these problems, the world of shore fish and the realm of deep sea life. This last year the Director and his staff spent six and a half months on Nonsuch, and the result is a better focused picture with much greater detail than ever before.

We have tried to get away from the conventional fisherman's or ichthyologist's point of view and see the thing as a whole. Our visualization is of the lonely mountain peak in mid-ocean and well within the Sargassum Sea, rising up and up two miles from the bottom slime. Close about it at the surface of the water and in all the bays and inlets is a host of fish, from min-

Looking northeast toward future home of the Department of Tropical Research.
From a photograph by William Beebe.



A new species of lantern-fish, *Pseudoscopelus stellatus* Beebe. From a water-color drawing by Else Bostelmann.

nows to giant groupers which make their home there. They are like Sir George Somers and his ship-wrecked adventurers in that they have reached Bermuda by misadventure, some from the Azores or even the waters of Europe, mostly however, from the warm shallows of the West Indies, blown across the seven hundred miles of intervening ocean by storm or tide-driven currents, travelling beneath the shelter of floating logs or seaweed, or sprayed off from the Gulf Stream two or three hundred miles to the westward. In one way or another they have reached this pelagic haven, found food and shelter, and have taken up their life there. We have a list of three hundred and thirty of these shore dwellers, as opposed to true pelagic fish, whose haunt is the open sea, and who are only now and then found close to Bermuda, taking it in their stride, as one might say, on their way past from one part of the Sargassum Sea to another.

The third division, separated only imperfectly from the pelagic, is that of the deep sea fish. Under this heading we class those which show very decided adaptations to their strange haunts, or which come rarely if ever to the surface. Here again we have recorded over three hundred species.

The usual thing to do in studying the fish life of any one locality is to collect and identify the specimens, make a list and publish it. We did this in Haiti,* although we lifted it well above the rank of a mere locality list, by adding a great deal of new material in the form of habits and other data. This we are planning in Bermuda. In a few months we will have a Hand-Book of the Shore Fishes which will contain keys for naming and adequate descriptions for identification. But this is a mere preliminary.

The ten thousand and one notes we are making in the course of our seasons on Nonsuch deal with the life histories of all the fish, lives of which we know so very little. As I have shown the Zoological Society in lectures, articles and pictures, we are doing all this in every conceivable way, grubbing about in tide-

*Zoologica, Volume X, Number 1.

A new species of deep sea gulper eel fifty-five inches in length, taken at a depth of nine hundred fathoms, *Saccopharynx harrisoni* Beebe. From a pen-drawing by Else Bostelmann.

pools, seining, fishing with hooks and lines, diving regularly to six and seven fathoms in helmets to observe, trap, harpoon, shoot and dynamite the particular specimens we want, besides which we descend to unheard of depths in the Bathysphere. We put live fish in aquariums and watch them for days, or we photograph, paint and dissect. Chiefest of all we try to interpret their activities, not in terms of human psychology, not as man to fish, but as fish to fish. In spite of this however; we are constantly being surprised out of our complacent new point of view by habits and interrelations, by emotions and sustained efforts in definite directions which, to our ordinary conventional beliefs, are as unfishlike as speech would be in a shark, or gills to a human being.

Returning to Nonsuch each year has always the elements of a Christmas morning; there is invariably some surprise awaiting our arrival, usually a gift of the friendly, generous Bermuda government. This last year it was telephone and electric light wires which, for our especial benefit, had been strung across Cooper's Island and Nonsuch Scaur to our laboratories, connecting us for the first time with the mainland and so with the whole outside world, aurally and illuminatingly.

No descents were made in the Bathysphere during 1931, first because there were no protracted periods of absolutely calm weather at sea, and because Mr. Barton was unable to come to Bermuda. The entire apparatus has been overhauled and is in perfect working order for the half-mile descent which we hope to make this summer.

The work in every department of the laboratory made big strides. Mr. Tee-Van devoted much of his time to the shore fish and in the present number of the Bulletin presents an interesting résumé of discoveries regarding the change of pattern in the growth of one species of wrasse; Miss Hollister added an ultra-violet light machine to her battery of apparatus for dyeing and making fish transparent, and the astonishing results are told in succeeding pages; Miss Crane began intensive studies from an entirely new angle, of the scales of the more primitive fishes.

The deep-sea fish catalogue was increased by twenty-five hundred new entries, bringing the total to over twenty-four thousand. The last

net hauled was number 1350, all within the eight-mile circle, and in the imaginary cylinder from the surface to one thousand fathoms or a mile depth. In the identification of ten thousand deep sea fish, especial attention was paid to color and distribution of light organs, and to growth stages. More than one hundred abyssal fish were kept alive in the refrigerators.

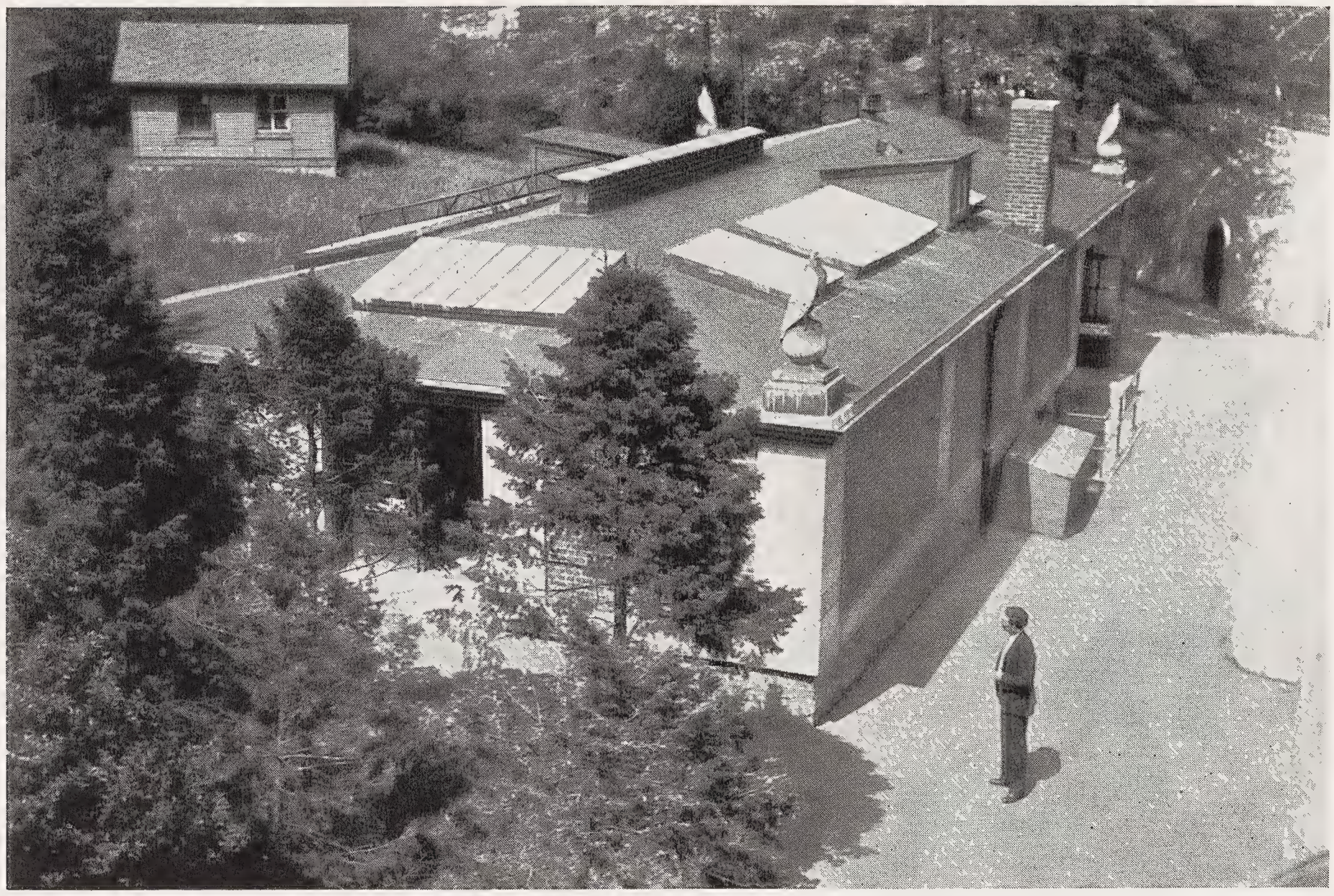
Thirty-three contributions were published during the year, bringing the total of the Department of Tropical Research to three-hundred and seventy-nine. A French translation *"Sous La Mer Tropicale"* appeared and an early British Guiana volume was turned into Braille for the blind.

The first of the Bermuda volumes, published under the auspices of the Zoological Society is an introductory series of essays by the Director, "Nonsuch: Land of Water," which has just appeared. Within a few months this will be followed by the Hand-Book already mentioned, and later by the large, monographic Life Histories.

The most unexpected discovery of 1931 was what appears to be a submerged beach, a mile and a half down and over ten miles from Bermuda. In the course of our trawling, whenever a net accidently struck bottom, if it was not torn away it brought up thousands of Pteropod shells, exquisite in delicacy of texture and in beauty of outline. These are literally flying snails which flap their way through life in the dark mid-zone a mile down, and when they die, their shells drift down to the bottom, there to form what is known as Pteropod Ooze. This is found only in a few restricted places in the seven seas, and it happens that the only patch in the north-western Atlantic is on the floor of my trawling area.

When I began dredging in earnest this last year I encountered unexpected difficulties. Strong, iron four-foot dredges were used, and only one or two hauls were made with each before it was lost, or twisted and bent into fantastic shape. The half-inch mesh netting allowed the Pteropods to slip through but retained all the larger material, and this was of the utmost interest. It consisted almost entirely of water-worn pebbles, shells and bits of coral. Hauls at nine miles distance from shore and others twelve miles out yielded identical results. The gradient of the bottom

Water-worn shells, pebbles and bits of coral brought up from a depth of a mile and a half, and twelve miles south of Nonsuch. Alcyonarian, *Dasygorgia* sp. Crustacean, *Galacantha rostrata* Edwards. Photograph by Amos Burg.



New laboratory of the Department of Tropical Research as viewed from the south-east.

from the dry land of present Bermuda to our dredgings is about one in six, which would seem to preclude all possibility of the pushing or rolling of bottom refuse down from the present shore. Furthermore, most of the shells we brought up are exactly like fossil mollusks which occur high up in Bermuda cliffs as well as in the West Indies.

The lowest levels of oceanic water at the glacial periods have permitted to geologists estimates of an increased land area from the present twenty square miles—about the area of Manhattan Island—to twenty times as great, about 230 square miles. I have had no time to extend the dredgings beyond my eight-mile circle, but at a most conservative estimate the addition of an indicated former Greater Bermuda would amount to sixty times the present area, or roughly 576 square miles.

This theory of a submerged beach is well substantiated by the character of all the bottom area of my trawling locality. The sea bottom a mile and a half down is usually rolling but smooth and covered to considerable depths with mud, clay or ooze. Here my nets are almost always torn to shreds the moment they touch, and the heavy iron arms of the dredge are twisted or the cable end is snapped by obstacles in the path of the haul. The small bits of these obstructions which are broken and brought up, show them to be the same water-worn, marble-like projections which characterize the reefs near shore—tall, jagged, iron-hard, sharp-pointed limestone, *in situ,* indicating former exposure to air and wave, wind and rain action. On the other hand the elevation of the sea bottom from a mile and a half to the surface and subsequent return to that depth is an unheard of phenomenon. With my present data I can see no other interpretation however. Further continued investigation will prove or disprove my suggestions. In any event it is as interesting as it was an unexpected result of our dredging.

One, among many amazing fish brought up in the nets from nine hundred and a thousand fathoms, was a new species of *Saccopharynx* eel which I have named *harrisoni* in honor of Harrison Williams, who together with the late Mortimer Schiff made this exploration possible. It was jet black with a huge curved mouth lined with sharp teeth, and measured only five inches under five feet. The anterior part of the body was thickened and was found to contain a good-sized fish also of a species new to

science. The posterior part of the eels was drawn out into a long, attenuated tail, near the tip of which was an expanded, leaf-like, scarlet light organ.

Another new form was a Lanternfish, *Pseudoscopelus stellatus*. Closely related species have been described from preserved specimens as possessing large numbers of mucus glands. In the recently dead fish these were seen to be light organs giving off a brilliant green glow. This, together with hosts of other facts, some of them indicated in the accompanying illustration, points my next paragraph.

As in all former work on our expeditions, the collections brought home consist only of individuals and series representing some definite fact, or theory or reason for comparison. The major part of our observations and researches are upon living fish in their haunts or in aquariums or immediately after death, before the body organs, skin texture and even patterns and colors have altered or been lost. It is for this reason that a comfortable working station is necessary, with well-equipped laboratory, aquariums, electric light, microscopes, dark room and drawing materials ready and at hand for instant use. And it is because of our first-hand observations under water that we are getting unusual and intimate results.

As to plans and prospects for the present year; the first week in January Mrs. Beebe and I spent in Bermuda attending the opening of the Rockefeller endowed Biological Station for Research near St. Georges. The large building, formerly the Shore Hills Hotel, has, thanks to the efficiency of Dr. E. G. Conklin, been made over into a thoroughly up-to-date marine laboratory. President Conklin installed Dr. J. F. G. Wheeler of Plymouth, England, as Director, and the Station was formerly opened.

Realizing that in the present era of depression, our expedition this year must be carried on with the strictest economy, I looked about and found the solution ready at hand. A well-built house with wide verandahs and generous grounds, situated on a wooded hill, with boat-house fronting on Castle Harbor, close to the Biological Station, and directly opposite Non-such was found available at a very moderate price. I rented it at once, taking an option for ten years lease or purchase and thus insured

General view of inside of new laboratory of the Department of Tropical Research, looking south. The collections of the various expeditions of the Department are being studied in these quarters.

Present staff of the Department of Tropical Research. From left to right are, Miss Hollister, Mr. Tee-Van, Dr. Beebe and Miss Crane. Photograph by World Wide Photos.

at least a temporary home. This I consider as my gift to the Society.

The Zoological Society, through President Grant, has become a participant in the new Station, and I have engaged a four-room cottage on the grounds and board for my staff for several months. This will enable us to carry on at minimum expense without sacrificing any of our usual opportunities. Nonsuch can be reached in a few minutes by launch, the daily catches of the fishermen of Bailey's Bay will be available, and the rich reefs of Castle Harbor are at our door. If we find we do not have to postpone deep sea exploration, the tug Gladisfen can tie up at our dock on her way back from sea, and the same facilities apply in the case of a descent in the Bathysphere.

Best of all we will be associated with many workers in various fields of marine research from whom we can get helpful suggestions and whom, in turn, we can aid with our experience and apparatus. With an unlimited field for discovery and investigation, as wide and deep as the ocean, with enthusiasm such as only naturalists and scientists can know, we are looking forward to another year of hard work, conscientious observation and the only reward which awaits such efforts—the solution of problems which make room only for other problems.

In the midst of all the depression, the confusion of life, the upsetting of so many long-established phases of civilization, a few things are encouraging to me and to my trio of co-workers. The number of lectures relating to our Bermuda work which are in demand during the present year from New York to California is astonishing; a month before publication, the Zoological Society's first book on Nonsuch has sold out the complete enlarged first edition. On our island we hear no faintest echoes of the strife of Mongolians, the tragedies of Wall Street, the silly eternal squabble about a scotch and soda, and the murder, robbery and mayhem which fill our papers. Even the fish themselves seem to declare a truce in Bermuda, for we continue to dive safely among the barracudas and sharks, while elsewhere in the world according to non-divers, their single obsession seems to be to crowd into the headline of some newspaper as Man-Eaters! Our good fortune may well be because we sacrifice to Poseidon, Athene and St. Francis!

Color Changes in the Blue-Head Wrasse
Thalassoma bifasciatum (Bloch)

John Tee-Van

FINGER-PRINTING has become such a completely established method of identification of human beings, criminal or otherwise, that no one even ventures to question its results. No matter how we attempt to change our appearance, whether by simulating age, dyeing our hair, growing beards, or altering our clothing or characteristic attitudes, always there remain the loops, whorls and lines that mark us off as unduplicated individuals.

Unfortunately, fishes lack fingers and as no adequate piscine substitute has been found for dactyl tell-tales, misidentifications have arisen, especially among the more brilliantly colored wrasse and parrotfish. Many of these fish change radically as they grow, foreheads become sharper or acquire strange lumps, the tail becomes differently shaped, contours alter, and relative proportions of the body such as the depth and the size of the head and eye are quite different in the young and old. In color even greater alterations occur; some of these can be assigned to growth, others are the product of momentary excitement, either of the chase or of being chased, of food or of sexual emotion.

Because of this lack of a specific determinant, it is inevitable that relationships between extreme forms should not be recognized, and that two or more technical names should sometimes have been given to representatives of the same species. And it is only by the constant gathering of scraps of information, like finding and assembling the parts of a jigsaw puzzle, that the life-histories of fish can be known, and the right sorts joined together.

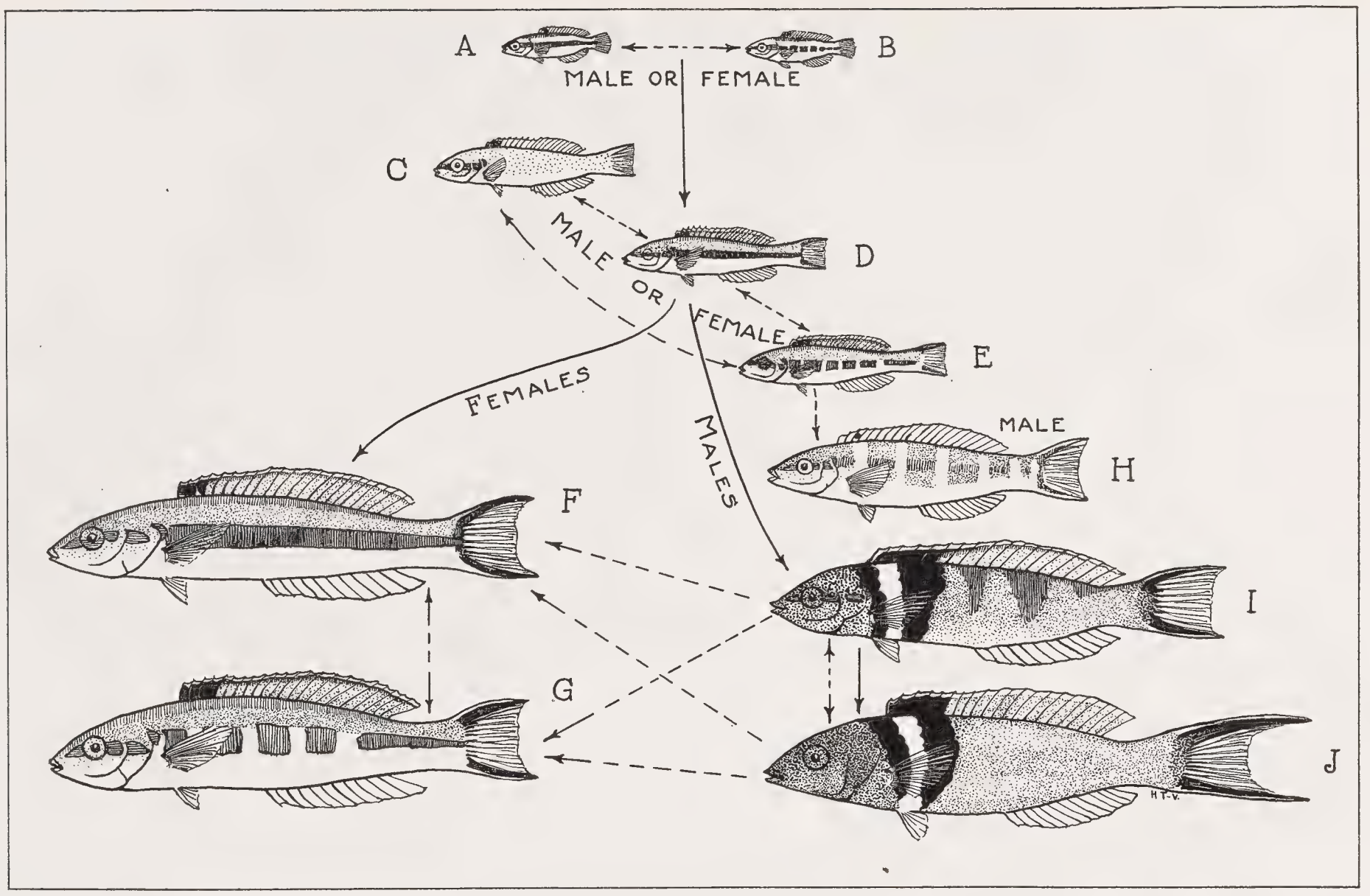
In Bermuda during the last three years, considerable work has been done on the unraveling of the color changes of wrasses, and especially of the Blue-head (*Thalassoma bifasciatum*). This species is of especial interest in that it possesses widely differing color phases, the extreme forms of which hardly resemble each other. A few recent authors have recognized that some of these forms were the same, but this has also been denied. In connection with this it may be mentioned here that the species known currently as *Thalassoma bifasciatum*, *Thalassoma nitidum* and *Bermudichthys subfurcatus* are all the same. The type of the last mentioned is a very dark specimen, whose fins have become damaged so that the spines are difficult to count.

Blue-heads are elongate, small-mouthed fishes growing to about six inches in length, the males being known in Bermuda as "King Slippery Dicks" and the females as "Scotch Slippery Dicks"—the Slippery Dick portion of their name being in allusion to their ability to wriggle through one's fingers when caught. This characteristic and name they share with many of their wrasse cousins.

The name "Blue-head" properly applies only to the adult male of the species, who alone possesses the chromatic qualifications. The males have deep blue or partly green heads, sometimes with irregular purplish spots on the lower sides, followed by two rather wide vertical black bands, separated by a pale blue interspace; the remainder of the body is rich bottle green, each scale of which has a trace of purple. There is also a conspicuous black spot on the anterior part of the dorsal fin, a small one at the base of the pectoral, and a larger more diffuse spot on the tip of the same fin.

The young and females are quite differently colored. During the three years at Nonsuch, where the species is abundant, hundreds of examples have been captured and observed, ranging in size from two-fifths of an inch to six inches in length. These specimens were almost kaleidoscopic in their variations of color and pattern, and yet out of this apparent jumble, there can be shown a progressive change of pigmentation from the smallest fish to the adults, some of the stages of coloration having temporary environmental phases.

Although the variation in color in the Blue-head is wide, and while two specimens are



Color-changes of the Blue-head Wrasse

A. Young, continuous band; B. Young, broken-band; C. Intermediate sizes, yellow outer reef stage; D. Intermediate, continuous band; E. Intermediate, broken-band; F. Female, continuous band; G. Female, broken-band; H. Male, night coloration; I. Male, adult coloration not fully attained; J. Male, full coloration. The broken arrows represent color changes; the solid line arrows represent growth. Drawing by Helen Tee-Van.

hardly ever alike, a number of extreme forms stand out as end products. The color of the male already has been mentioned and that of the youngest will be described later. In addition to these there stand out most prominently the color of the adult female, that of the yellow phase found on the outer reefs, and for want of a better name, what we have termed the "night" coloration.

A typical four inch female, recognizable as wholly different from the male, has the coloration as follows: Upper part of the body and sides of the head yellow green, the lower third of the head pale salmon, and the lower third of the body pale blue with a pinkish tinge; a series of five, indistinct dark blotches along the middle of the sides; a broad reddish-brown band from snout through the eye to the edge of the preopercle; a large similarly colored blotch on the upper part of the opercle. Dorsal fin greenish at the base, then dusky, with a fairly broad transparent band along the upper edge, this band narrowed anteriorly. This dusky band becomes more intense as it progresses forward, becoming a black blotch on the anterior part of the fin. Caudal fin with upper and lower margins almost black. As can be seen from this description practically the only thing common to the male and female in their extreme stages, is the possession of black lobes to the caudal fin.

On the outer reefs, and observable down to depths of sixty to seventy feet are the yellow representatives of the species. A typical one has the general color of the body above and on the sides, including the caudal fin, rich yellow, sometimes with an orange tinge. Lower surface white or bluish tinged with pink. A broad band of terra-cotta red from the snout through the eye, continued as blotches on the preopercle and opercle. Dorsal fin greenish or grayish, sometimes almost colorless, with a pale blue marginal band, and with an intense black spot on the anterior membranes of the spinous portion of the fin. Caudal fin bluish along the upper and lower lobes.

In our aquariums some of these yellow fish have changed first to a pattern similar to that of the adult female, and then to "night" colora-

tion. This can be described as body grass green with six vertical whitish bands narrower than the interspaces, extending downward from near the dorsal fin and merging in the pale pinkish white of the abdomen and lower surfaces. Head bluish green above, the red spots and bands on the head present and conspicuous, this color continued through the eye. Dorsal and anal fins similar to the adult male Blue-head. Caudal fin with its upper and lower lobes bluish. In this form the quadrate black blotches of the adult female are occasionally present in the green.

It must be emphasized here that in the field at Bermuda, intermediate specimens between each of these extreme forms have been found, and individuals have been watched as they changed from one phase to another, so that the entire assemblage has been connected together as a single species.

In tracing the development of the color pattern, we can start with the relatively simple pattern of the smallest fish, which can be altered slightly, and watch the changes as the band on the head breaks up and as the lateral band on the body becomes a series of quadrate blotches, two of which later become the black vertical bands of the males. As the fish grow older, both males and females have the same general color and pattern, varying widely, and assuming yellow or night coloration as they choose. The females, always retain this generalized coloration, while the males at a little over three inches in standard length may show traces of their adult colors, and beyond this length they gradually assume their striking coloration. Even they show reluctance to limitation of their ability to vary, and may at the slightest cause, throw off most of their blue-head color and assume parts or nearly all of their consort's livery. But judging by the dissection of some fifty-two males, any fish that shows a trace of the blue head is a male.

As an easy means of tracing the development of the color patterns, the youngest fish taken by us (2/5ths of an inch long) is described first, its pattern dissected, and then each of these pattern elements followed through the life of the fish.

Young individuals of this size were found quite commonly in tide-pools, but they are not confined to shallow water and also frequent the outer reefs at thirty-five to forty feet depth. They are generally pale grass green above, the lower parts white with a marked pinkish tinge. There is a wide lateral band from the snout where it meets its fellow from the opposite side of the body, through the eye to the caudal fin; the portion on the head reddish to deep mahogany brown, that on the body black. A wide blackish-brown band extends down the middle of the dorsal surface from the interorbital space to the end of the dorsal fin, this is bordered below by a narrow pinkish band rather indefinite in extent. Anterior portion of the dorsal fin between the 1st and 5th spine black, the remainder of the fin dusky, becoming less so posteriorly, and with a rather wide transparent edge which increases in width posteriorly. The anal fin has a narrow, pinkish horizontal band near its base and the remainder of the fin is translucent. The caudal fin is also translucent with a faint yellowish tinge basally and a pinkish tinge in the middle of its lobes. Pectoral and ventral fins colorless.

This small specimen gives us the basic pattern from which all the later color phases are derived. The color units present in the small fish and the few that appear later are listed as follows:

1. General body color.
2. Dark band on body along base of dorsal.
3. Brown spots on side of head, continued as—
4. Black band along sides to caudal fin.
5. Spot on anterior portion of the dorsal fin.
6. Remainder of coloration of dorsal fin.
7. Anal fin coloration.
8. Caudal fin coloration.
9. Spot at base of pectoral fin.
10. Spot at tip of pectoral fin.

Taking these units individually the changes can be shown as follows:

1. *General Body Color.* In the smallest examples this is usually yellowish or greenish yellow above and white below, with pinkish edges to the scales. The yellow may disappear entirely, the result being a white fish with a horizontal black band. But as a general rule

as the fish grow older they retain these brilliant colors, becoming at times completely yellow above and whitish beneath, or else green above and pale below. In the adult male the entire posterior body is rich bottle green and the rest of the body color as it has already been described.

2. *Dark band on body at base of the dorsal fin.* This band is found only on the young and apparently disappears as a conspicuous color unit after an inch and a quarter has been reached, although it may be indicated as a darkening of the dorsal surface in still larger specimens.

3. *Brown band or spots on side of head.* This pattern is one of the most conspicuous and ranges through all stages with the exception of the adult males. In the smallest fish (2/5ths inch) it is in the form of a continuous band, beginning on the snout, going through the eye and crossing the opercle, then joining the black band along the middle of the sides. At an inch to an inch and a quarter the portion before the eye remains as a single elongate spot, while that behind the eye divides into three, the posterior of which is smallest and obliquely elongate. While the blue-head coloration of the male is being attained the group of red spots become smaller and eventually disappear. For a long while the absence of the red on the head of the adult male blue-head seemed to be the last stumbling block to connect this form with the others, but after two year's work, specimens with slight indications were found.

4. *Horizontal band along side of body.* In a 2/5ths inch fish this band is exceptionally prominent, usually quite intense in color and ends posteriorly in a slightly darker black spot which is absent in larger fish. The edges of the scales are pinkish in many smaller fish, similar to the scales of the lower surface, thus giving a pinkish-brown appearance to the band. Even during the earliest stages this band may break up into a series of quadrate spots, usually six in number, the individual fish changing back and forth through life from band to series of spots at will. From an inch and a half in length upwards, and possibly in smaller specimens also, although this has not been observed, this band may disappear entirely and this is especially true of the yellow form, where it is usually absent, but occasionally indicated by a slight duskiness or blueing.

In fish that are in what we have called the "night" phase, this band of spots becomes less intense in color, changing to lighter green, expanding and becoming more diffuse, and extending upward to the dorsal surface, thus producing a fish with wide green bands reaching from the dorsal surface to the lower sides, separated by narrow white bars. This coloration may be restricted to males, as so far we have found it only in that sex.

In the adult males the first and second of the dark quadrate areas are the beginning of the black bars on the anterior body. In males of complete blue-head pattern, however, the posterior spots may suddenly intrude themselves upon the green body.

5. *Spot on anterior portion of the dorsal fin.* This is present at all ages and in every fish examined. In the smallest fishes it is a broad oval, but it soon (¾ inch fish) occupies the space on the anterior membranes of the spinous dorsal from the 1st to the 3rd or 6th spine. The spot does not always extend to the bottom of the fin and it is surmounted above by pale blue. In fishes of reduced coloring it occasionally is reduced to a small spot between the 3rd and 4th spines.

6. *Remainder of dorsal fin.* In the youngest fish the upper part of the fin is transparent, the lower portion dusky, the dusky portion being a pale continuation backward of the anterior black spot. This dusky portion becomes lower and lower as it progresses backward and almost disappears at the posterior end of the fin. In slightly larger fish (1¼ inches) this dark lower part of the fin is present only as a trace. The fin in all later stages is dusky with a greenish tinge or green with a narrow, submarginal blackish line extending from the upper portion of the black spot to the posterior end of the fin, the submarginal band being bordered above by a marginal one of blue. The presence or absence of these lines is variable, and in pale specimens they are visible only as minute ghost lines.

7. *Anal fin coloration.* In small fish there is a narrow pinkish band near the base of the fin, the remainder of the fin being transparent with

a greenish tinge. In older fish this band disappears and the anal fin is transparent with a bluish or greenish border.

8. *Caudal fin coloration.* This fin is colorless in small fish, becoming tinged with blue or gray or green in larger specimens, and in the yellow phases it is often bright yellow mesially. The black along the upper and lower edges of the fin may appear at quite early stages. A ¾ inch fish shows well developed caudal lobe patterns. These black patterns come and go quite rapidly, and may be present or absent at any stage, although always present in the male blue-head.

9. *Spot at base of pectoral fin.* This very small black spot is present on all specimens over an inch in length; no indications of it can be found in smaller fish.

10. *Spot at tip of pectoral fin.* A diffuse black spot is present on the tip of the pectoral fins of larger specimens only.

Reference to the illustration will help to correlate the various elements of the color pattern. An attempt has been made to show by means of solid arrows the changes that occur with growth, and with broken arrows to indicate the temporary changes from one phase to another. It will also be noticed in the illustrations that there are other changes with age in the Blue-head, such as alterations in depth and size of head as well as a complete difference in the shape of the tail. The latter is rounded in the young, becoming truncate as the fish grows older, later somewhat crescentic, and in the adults the upper and lower lobes are produced, to a small degree in the female, and markedly so in the male.

Just what value can be given to the assumption of this variegated and changing Joseph's coat of this wrasse is a question, because in no part of its life, does the Blue-head attempt to adapt its color to the surroundings. At all times it advertises itself, being either black and white or brilliant yellow, or equally bright green and blue. Coupled with this blazing outburst of color is the fact that it is always in evidence on the outside of the reefs, never attempting to hide in crevices or interstices in any way. As is the case with many other reef-inhabiting fishes of vivid coloring, it is doubtful if any value can be attached to the color, either from the standpoint of protective or warning coloration. The only evidence that the Blue-head might be considered as warningly colored, and which is of negative value only, is the fact that we have never taken Blue-heads in any color stage, from the stomach contents of the carnivorous reef-fishes among which they live.

The most abundant phase of the Blue-heads is the brilliant yellow one found mainly on the outer reefs, and whatever the conditions are that produce this color, it is of interest to note that a xanthistic phase is found also in three other Bermudian reef fishes, two of these being wrasses of the genus *Iridio* and the third the yellow surgeon-fish (*Acanthurus heliodes*), which most likely is the yellow form of the blue surgeon (*Acanthurus caeruleus*). The two Iridios and the yellow Blue-heads are often found together in small schools of twenty to thirty, or sometimes up to a hundred in deeper water, apparently paying no attention to each other but doubtless benefiting from association. Both of the Iridios in their normal forms are fairly dark fishes with conspicuous patterns, the first being *Iridio meyeri,* the yellow phase of which can be easily differentiated from the others by the possession of three reddish cross bands across the upper posterior portion of the head; the second, *Iridio garnoti,* which can be distinguished by a narrow blue line along the middle of the sides. The yellow surgeon-fish lives under exactly the same conditions as the others, with the exception that it is usually solitary.

It must be noted, however, that the yellow phases of these three species are assumed only by medium-sized individuals, and it may possibly be that this coloring is characteristic of gregarious adolescent fish, which later spread out and become less sociable.

It can readily be seen that with all of this variation and indeterminateness, that any method or means that would make certain the identity of two fishes of intimate relationship but of casual resemblance, other than piecing minute bits of evidence together, would be of inestimable value in ichthyological studies.

Here lies the preventative of ichthyologist's gray hairs, and he who finds the substitute in fish for finger prints will be called blessed.

Upper. *Echiostoma ctenobarba* Parr, before irradiation. Center, Sun lamp of the Hanovia Chemical Company used for irradiating specimens. Lower. *Echiostoma ctenobarba* Parr, after irradiation, showing tiny skin photophores. Photographs by John Tee-Van and Amos Burg.

A New Use of Ultra-violet Radiation

GLORIA HOLLISTER

IN connection with my studies at Columbia University in 1924 and 1925 I was particularly interested in the bony structure of animals and used several well known tissue-clearing techniques to eliminate tedious and injurious dissection of the specimens. The clearing processes of Lundvall, Spalteholz, and Schultze have been used for many years. But after the specimens were run through the various chemicals to make the soft parts transparent the final results were never clear enough to satisfy my requirements.

During a certain phase of the process sunlight is a necessary agent to extract or bleach pigment from the tissues. Many times, just when the specimens had reached this critical stage, a prolonged spell of sunless days would make progress in depigmentation impossible. In the absence of the sun's rays I began to experiment with incubator heat and bleaching agents, such as hydrogen peroxide, ammonium hydroxide, and various acids. For some time I sought a controlled and adequate substitute for the rays of the sun. Finally, I decided to try exposing the specimens to ultra-violet rays.

Through the courtesy and generosity of the Hanovia Chemical Company of Newark, New Jersey, our department of Tropical Research have had the loan of a quartz mercury vapor arc lamp which is popularly known as an Alpine Sun Lamp. Because the ultra-violet produces pigmentation of the skin, society uses the Alpine Sun Lamp to acquire the popular winter sun-tan. This effect presents a startling antithesis to our results, the black deep-sea fish exposed to the lamp soon become bleached. In the living subject the ultra-violet acts as a catalytic agent producing chemical changes in the skin, but in lifeless tissues it becomes an oxidizing agent and bleaches the skin. This lamp proved so valuable in connection with the bleaching and clearing of hundreds of specimens that it has been in constant use since 1929 in the laboratory in New York City and in the field laboratory on Nonsuch Island, Bermuda.

The most harmless and satisfactory bleaching method had been exposure to sunlight, so the wonderful results from the ultra-violet light were not altogether unexpected. The great convenience of having the essence of sunlight under control in the laboratory ready for use when the specimens need bleaching cannot be overestimated. Ultra-violet rays are much more effective as a source of energy than sun rays.

This is the only treatment which, without damaging the specimens, will extract the black pigment from deep-sea fish and render the tissues crystal clear with every detail of bone visible. Another great advantage of using the ultra-violet light in conjunction wih the clearing process is the fact that the specimens treated are transparent and ready for study much sooner than those that have not been irradiated. Instead of taking weeks and months to complete the whole process it is now only a matter of hours and days.

The illustration shows the Alpine Sun Lamp in the process of irradiating black deep-sea fish. After several hours the exposed sides of the specimens were many shades lighter than the unexposed. The two photographs are of the same fish (*Echiostoma ctenobarba*) before and after two days' exposure to the ultra-violet. The color tone changed from jet black to light brown. The hundreds of minute light-organs in the skin were not visible until after irradiation for two days when the delicate photophores became as clear-cut as though etched. In order to appreciate the full significance of the light systems of deep-sea fish a study of the bleached specimen is almost necessary.

Numerous experiments were made to determine the best fluid in which to immerse the specimens while exposing them to the ultra-violet. Good results were had in combination with several solutions but by far the best proved to be weak sodium or potassium hydroxide. The irradiation in combination with either of these fluids not only bleaches the skin but speeds up the clearing of the tissues. Experiments were also tried to determine the best period during the clearing process to irradiate the specimens. For detailed study of the bony structure it is preferable to irradiate the fish during the early phase of the clearing process before the specimen is subjected to any specific dye.

The preceding introduces a new use of the ultra-violet in the domain of pure science. It

may be interesting now to consider the gradual development of modern heliotherapy from ancient heliolatry.

The existence and the continuation of life depend primarily on energy derived from the sun. Light is the great synthetic force on the earth's surface that stimulates plant and animal growth. Sunlight is the spark that fires the dormant life in plant seeds, and those that fall in a densely shaded spot in a tropical jungle have a poor chance to live. But the fortunate ones, encouraged even by intercepted rays flickering down through the branches of the giant trees, soon enter the competition of the jungle—the rapid race upward to the open fields of treetops and sunshine.

Aquatic plant life also needs light and consequently many of the attached algae are found growing near the surface of the water. In addition, plankton-algae are found only in the upper water layers. As far as we know all forms live within the light penetrating zone.

Many animals instinctively seek the sunshine for a certain part of each day. Like animals, man has worshipped the sun ever since he lost his coat of hair and became man. During the time of drought primitive man worshipped rain-gods and during prolonged rain-spells sun-gods were evoked to help the crops. To-day, the clergy pray to their Supreme Deity to send rain and sun.

In the era of ancient Rome and Roman baths the healthful effects of the sun were recognized and for many years sunshine has been the basis of doctor's prescriptions for those who wished to retain or recover health.

Recently, the vital and apparently indispensible element of the solar rays has been discovered—the ultra-violet. Although the ultra-violet is invisible and according to Cobletz and Stair constitutes less than one per cent. of the solar radiations it is considered the necessary element of sunshine. A single quartz-mercury vapor lamp emits a flood of light which contains approximately twenty-eight per cent. ultra-violet rays which is about twenty-eight times more than is radiated by the sun. It produces artificially the chemical force which the sun supplies in such a small amount.

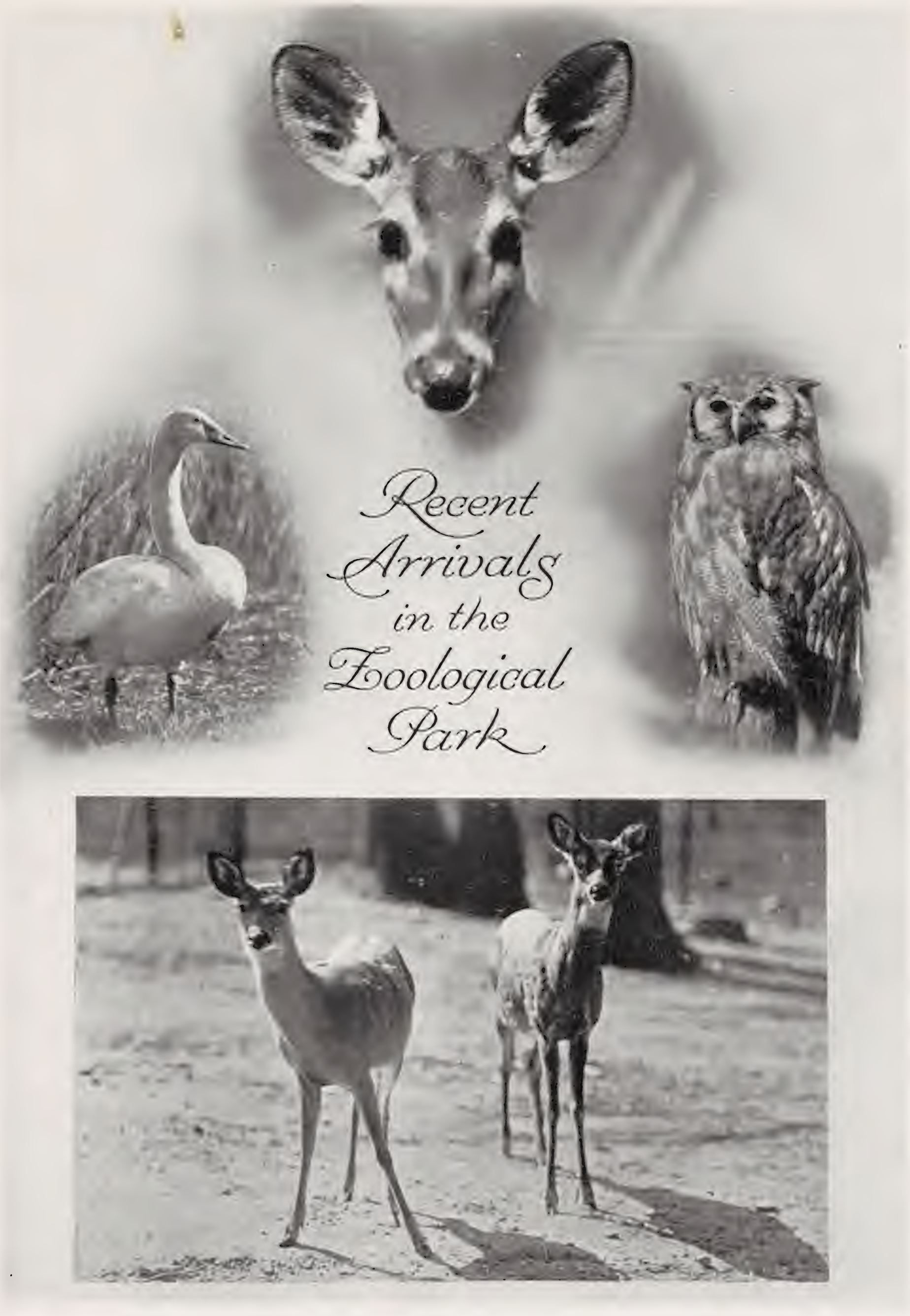
In the commercial and utilitarian world the use of the ultra-violet rays is now widespread. Recent experiments show that certain plants will grow continuously for twenty-four hours if radiated with light. Growth is not checked by excluding ultra-violet rays from the light but the food value is seriously affected for vitamin D is lacking which is valuable in preventing rickets. This quality is readily added by irradiation with ultra-violet rays.

About a decade ago ultra-violet was first tried on poultry as a substitute for sunshine. The beneficial results were so marked that now most commercial poultry farms irradiate the birds, both young and old, at least once a day during the winter months when the sun is low and confinement indoors is necessary. Among the young birds receiving this treatment loss from disease is infrequent and growth and maturity are much more rapid. Fertility and hatchability of the eggs from the old birds irradiated are improved about twenty per cent. and egg production is increased about six times. Veterinarians in private practice and in charge of zoos employ the ultra-violet for preventative and therapeutic measures.

A comparatively new experiment is the irradiation of foods for human consumption such as milk, bread, and cod-liver oil. Initial results hint that this may be a valuable way to revitalize our food and increase its energy producing qualities for the motive power of our bodies and brains.

In the medical world the modern uses of the ultra-violet are many and varied. Physicians use heliotherapy constantly. Because the ultra-violet is powerful in killing bacteria on the surface it is widely used for specific treatment. Dr. Hess has demonstrated that the young, rapidly growing infant thrives best when deprived of the visible rays than when deprived of the ultra-violet rays of the sun. With babies and children the ultra-violet acts as a preventive for rickets, nutritional diseases, and antigrowth factors. Ergosterol, which is present in foods and the skin, is activated by ultra-violet rays and becomes vitamin D which is required for bone formation. This fact alone emphasises the great importance of getting rid of smoke pollution of the air. Smoke, fog, walls, glass, and cloths cut off the ultra-violet rays.

It is an interesting fact that the ultra-violet which is used in so many practical ways can also be a vital tool in the intellectual realm of pure science.



Left. Whooping swan. *Right*. Milky eagle owl. *Lower*. White-tailed Deer.
Photographs by E. R. Osterndorff.

Upper. Young chimpanzee. *Center*. Black-bellied sand grouse. *Lower*. Nine-banded armadillo. Photographs by E. R. Osterndorff.

Upper. Dalmatian pelican. *Center*. Capybara. *Lower*. European hedgehog.
Photographs by E. R. Osterndorff.

An Australian settler's homestead on the Murray River. Spotted bower-birds frequent the pepper-trees growing close to the main buildings. The bowers of this species are longer than those of the satin bower-bird, in many instances as much as three feet in length. They are outwardly built of twigs, beautifully lined with tall grasses so arranged that their heads meet. These bowers are decorated profusely with bivalve shells, and the crania of small mammals. Frequently the bowers are built at considerable distances from rivers, from the borders of which the birds could alone have procured the shells and pebbles; their collection and transportation, therefore, is a task of great labor. The nests are rather primitive and in no way compare with the elaborate work expended on the bowers. Photograph by Charles Barrett.

The Bower-Birds and Their Bowers

Some interesting notes by Charles Barrett on the Bower-building birds of Australia and the adjacent Islands, supplemented by observations made in the Zoological Park by Lee S. Crandall, Curator of Birds, concerning the Bower-birds, and the bower-painting of the Satin Bower-bird.

Illustrations from field photographs made in Australia by Charles Barrett and other naturalists, and from photographs taken in the Zoological Park.

THE more we learn of animal behavior in the wilderness, the less convincing become the theories based upon the "control" experiments by the professional psychologist. As a field naturalist, I have good reason to differ from such theories particularly concerning the habits and emotions of animals which I have watched often in the field. This brief introduction to a consideration of the Bower-birds will serve its purpose if taken as my reason—not excuse—for writing of Australia's wonder birds without using terms that are dear to the scientific behaviorist.

Recent independent observations by several accredited naturalists have confirmed those made a few years ago by a lonely watcher of the satin bower-bird (*Ptilonorhynchus violaceus*). This bird unquestionably uses a decorative *tool* purposely, and evidently derives pleasure in the beauty of its bower! No discovery in the realm of bird behavior more remarkable than this—that the satin bird paints its bower, using a "brush" for the purpose—has been made, at least to my knowledge.

The "painter" and other species form a fascinating group; and it has been my fortune to see many Bower-birds in their haunts, to observe them at their bowers, and even get on friendly terms with individuals.

New Guinea's Gardener bower-bird (*Amblyornis inornatus*) ranks higher than any other species in its appreciation of beauty—"an appreciation," as Professor Alfred Newton said, "perhaps unparalleled in the animal world." At the base of a small tree usually the Gardener builds, not a bower, but a hut-like structure about two feet in height, with a sloping roof of orchid stems that reach to the ground and radiate in a regular manner from the central support. A cone-shaped mass of moss crowns the support and shelters the gallery round it. Before the open front of their hut, the birds make a garden and place in it gaily colored flowers and berries which are arranged on a bed of green moss. As they wither, these blossoms and berries are removed to a heap behind the hut, and the "spot" is decorated anew.

I have no personal acquaintance with the Gardener, but the facts stated are well attested, and deserve a place in any general account of the Bower-birds.

The golden bower-bird (*Prionodura newtoniana*), with a limited range in north-eastern Queensland, is the master builder among the Australian species, and the most beautiful. The male is a brown and golden bird, with a short crest and neck collar of the bright yellow color which is more charming than that of real gold. The female is demurely dressed in brown. The bower or playground of the golden bird is notable for its size as well as architecture.

The only bower of the golden bird I have seen is that in a National Museum (Melbourne) group. Mr. S. W. Jackson, a field ornithologist with many discoveries to his credit, was the first to publish (in "The Emu") a photograph of the golden bower-bird's playground, and I quote his own excellent description: "The bower . . . which I photographed covered an area fourteen feet by six feet, and in the center the pile of sticks was over four feet high. The whole structure appeared to have no symmetry at all, most of the sticks being piled up about the upright stems of small trees. In the decorations there were large quantities of a long stringy forest moss, varying in color from a yellowish-green to a rich rust color; I also saw numbers of open pods, each containing a black seed, the latter in most cases being covered with a red skin, which was, however, in a state of decortication. In front of the bower and close to the ground hung a vine (*Viti*) in swing form, and this in all probability afforded a swing for these beautiful birds during their play at the bower."

I visited the golden bower-birds' haunts, when on the trail of the tree-kangaroo, but a search for bowers was unsuccessful. Scrubs in the

Male satin bower-bird at the entrance of its bower. Of all the species of bower-birds, this is perhaps the oldest and best known. The bower is usually built in the forest under the shelter of overhanging branches, and in locating its position, a space of two or three feet in diameter is carefully cleared of all debris. The bower is constructed of slender twigs inserted in the ground, arranged so that the tips curve inward and nearly meet at the top. The interior materials are so placed as to offer no obstruction to the entrance of the birds. The male is the chief workman, in the construction of the bower, which is decorated with any brilliant or curious materials that the birds can find, such as gaily colored feathers, bleached bones and shells. It is only the scene of courtship. Photograph by Charles Barrett.

Barron River Valley have been tamed for farming, are being cleared, or are doomed to destruction. Every year the area of wild, beautiful country becomes smaller. One envies the pioneer naturalists in this glorious region. They explored the scrubs or brushes before the richness of the soil germinated, in "practical" minds, the seed of desire for Atherton and other areas. The valley of the Barron offers the most romantic river-gorge scenery in Australia. And, before the era of clearing and cultivation, the tableland, covered in splendid rain-forest, was a paradise for nature lovers. Wild nature has still a share of that region, but is losing it steadily. Has not Atherton tableland soil been described by a great authority as the richest for agriculture in the world? No wonder birds receive scant consideration when their haunts are coveted by farmers! We can hope only that permanent reservations will save the native fauna to delight our descendants.

Kendall Broadbent, whom I knew in his old age, was one of those pioneer naturalists; he discovered the golden bower-bird, in 1882, and gave the original description of its wonderful playground, with little hut-like structures (gunyahs—aboriginal shelters or "huts," he termed them) dotted around it. Five huts were counted in a space only ten feet in diameter. The playing-place with its gunyahs resembled a blacks' camp in miniature. The birds, in their play, chase each other, running in and around the gunyahs!

Usually the bower is built on the ground, either between a bush and a tree, or between two trees. Twigs and small sticks comprise the building material. In the form, roughly, of a pyramid, they are piled around one tree trunk, more or less horizontally, to a height which varies from three or four feet to eight feet, or even a foot higher. One of the bower walls is raised perhaps several feet higher than the other. Around the trunk of the second tree is built a similar, but much lower, pile of sticks and twigs, while stems of climbing plants are used in the construction of an archway between the two pyramids. The arch, the higher wall and the runway are decorated by the bird builders, with white moss, clusters of green, grape-like fruits, blossoms and fern fronds.

Concerning those captivating little huts, opinions differ. Mr. George Sharp, who discovered the first-known nest and eggs of *Prionodura,* states that male birds only assemble at the huge bower, but the females also build bowers, about half the size of that sacred to the male. Mr. Alec H. Chisholm, in his notable book, "Birds and Green Places," records these observations and offers them as a possible explanation of the golden bower-birds' enterprise. What struck Kendall Broadbent as mimic blackfellows' gunyahs, he remarks, "were probably nothing more nor less than manifestations of feminine independence in the genus *Prionodura.*"

The golden bower-bird is richly endowed; to its skill as a builder and decorator, is added the power of mimicry. It imitates the calls and song notes of its feathered neighbors, and even the musical croaking of tree-frogs.

Rivalling it in beauty, the Regent bower-bird (*Sericulus melinus*) of northern New South Wales and southern Queensland, ranks far below *Prionodura* as an architect and builder. Indeed, this lovely bird—the male has rich black and yellow plumage—is at the Stone Age of bower-building. But we must judge it on comparatively few examples of its work. Strangely, though the birds are numerous in many parts of their range, less than a score of their bowers have been recorded since 1863, when the first one known to science was discovered. I have camped often in Regent birds' haunts, and spent many an hour observing the black and golden species, yet only one bower of the species has rewarded all my keen searching.

It was in a rocky bit of country, thinly timbered, but with patches of scrub, that I saw my one and only Regent bird's bower. With other naturalists, I had motored from Rockhampton, the capital of Central Queensland, to inspect Olsen's Caves. Three of us left the main party at the caves and wandered off through the Bush. I was collecting land snails, abundant among the rocks, when a shout rang through the timber, "A Regents' bower!" Snails were forgotten, I ran through the scrub towards my lucky companion.

The bower, built on the ground in the lee of a scraggy shrub, was the most primitive structure of the kind I had ever seen. Merely two walls of sticks, loosely constructed, with a suggestion of arching. The walls were seven to eight inches in height and rose from a bed of

"Painted" twigs from a bower of the satin bower-bird, in the Zoological Park. The significance of this newly discovered habit is not yet understood. The substance with which the twigs pictured have been decorated, is a decayed wood-pulp, mixed with a secretion of the bird's mouth. Photograph by E. R. Osterndorff.

sticks, irregularly. At the base they measured about six inches in width, less than half that midway to the top, where they tapered. The avenue was barely four inches across, and a few empty snail shells and freshly-plucked leaves were lying in, or close to, the bower.

But the Regent bird may gain as much pleasure from its primitive bower as the golden species does from its huge and elaborate structure. Here is Mr. A. G. Campbell's description of Regent birds at play: "When first seen there were three birds playing in the bower; two were what we took to be males—but they were immature—and the other was a female. The antics they went through were extraordinary, and they were not in the least disturbed by our presence. One would go into the center of the bower and, picking up a shell, of which there were three, would dance, half opening its wings and then tossing the shell in the air or over its head would run out. While this was going on the other two birds outside were scraping or sweeping the ground with their wings, and when the shell fell, one would pick it up and enter the bower to go through the same performance as the first bird, and so on." ("Nests & Eggs of Austln. Birds.")

Courtship doubtless has its place at "these highly decorated halls of assembly," as John Gould termed the avian bowers; but the observations of many naturalists and others since the great ornithologist's day have proved that the love emotion alone is not responsible for the bower-building habit. The birds build and use them at other times of the year than the breeding season; and both playgrounds and bowers are resorted to for "games" as well as for display and love-making. Besides, they are a manifestation of the birds' aesthetic sensibility. Those who have seen many bowers and playgrounds and observed the actions of their makers, have no doubts upon this point: Bower-birds appreciate beauty, though it be only that of an old bleached bone! Tastes differ with the species, however, and the satin bird, which delights in blue flowers and berries, is not a keen collector of bones.

I offer no theory as to the origin of bower-building among birds—a few species in this island-continent and its northern neighbor, New

Guinea. But consider the ways of the cat-birds, and formulate your own theory. New Guinea has several species; in Australia there are three kinds of Cat-birds, named for their curious notes, which, in some species, resemble the complaining voice of a domestic cat. The tooth-billed bower-bird (*Scenopaeetes dentirostris*), of North Queensland, is found in a restricted area, and is much less familiar than the cat-bird (*Aeluroedus viridis*), of South-eastern Queensland and the coastal region of New South Wales. The former species is classed as a cat-bird, though not cat-voiced; it is an excellent vocal mimic, almost rivalling that famous "mocker"—*Menura,* the lyre-bird.

The cat-bird, which is chiefly green in color, inhabits dense sub-tropical jungles, or scrubs as we term them, of the coastal regions. Its mew-mew call is frequently heard: it was one of the familiar sounds around our camp on the Williams River, New South Wales. The second mew is louder than the first lamentable note; and it was not mere fancy that suggested the popular name for this member of the sub-family Ptilonorhynchinae—bower-birds. Unlike the tooth-billed species, *Ailuraedus* is not a mimic of other birds' notes. The spotted cat-bird (*A.maculosus*) is a North Queensland species.

It is stated that cat-birds (*Ailuraedus*) occasionally form a playground of very primitive type; but I have never seen one, and agree with a friend, Alec. Chisholm, that the practice is not general with these birds. Admit a beginning, a step towards the playground, and the bower-building habit, what is the next stage? The tooth-billed bower-bird's habits, perhaps, represent it. This brown-plumaged dweller in tropical jungle, with its curious notched bill, has the playground habit, though not a builder of bowers. Like the lyre-bird, it clears a space, but not to form a dancing mound. The area, several square yards in extent (Jackson measured one twenty-six feet in circumference), is raked clean by the birds, all dead leaves, and sticks being removed. On the bare ground fresh green leaves are placed, with very rare exceptions, upside down. From about a dozen to over thirty leaves may decorate one playground. They are long leaves from a scrub tree (*Litsea dealbata*), and light-colored on the under sur-

Location of the bower of a satin bower-bird in the National Park, near Sydney, Australia. The large tree in the center of the picture is a giant Eucalyptus, and the bower was built in the scrub almost directly beneath it. A much travelled motor road was about one hundred yards distant. Photograph by Lee S. Crandall.

Haunt of the Regent bird in a cabbage palm grove on the borders of a swamp in southern Queensland. This species is the most beautifully plumaged bird known in Australia; a gorgeous combination of orange yellow and black. The male is about ten inches in length and the female, which is rather dull in color, is slightly larger. The bowers of these birds are small and rather primitive, not greater than ten inches in length. Photograph by Charles Barrett.

face. When they wither and begin to curl, they are removed from the cleared space, which is decorated with fresh ones.

The tooth-bill plays with its *Litsea* leaves—toys is perhaps a better term, and also spends hours, perched, at the playground, during which time it utters its own harsh notes, now and then mimicking the calls of other birds that inhabit the scrub. One bird only, according to Jackson's observations, frequents the playground: a fact that tells against the courtship theory.

None of the other bower-birds is so well known as the satin species, *Ptilonorhynchus violaceus;* none has been so extensively studied. It is widely distributed in Eastern Australia, chiefly the coastal region, from North Queensland to Victoria, where it inhabits the southern forest country, being numerous in many parts of Gippsland. An unfortunate acquired taste for cultivated fruit has made the satin bower-bird unpopular with orchardists in some localities, while it is also rather destructve in gardens and cultivation plots near its haunts, being fond of clover blossoms, sweet potato tubers and cabbages, as well as of cherries and strawberries. Flocks of these birds have been known to strip, in a week, several acres of mandarin orange trees.

Doubtless their depredations have been exaggerated, and satin-birds are not much persecuted in Victoria. They are partial to cake and meat sandwiches, and will fly down close to a picnic party in a national park, or other much frequented spot in their haunts, to take proffered tit-bits.

I have observed, at a distance of two or three yards, a satin bird eating a ham sandwich! This was in the great National Park near Sydney, New South Wales' capital city, where satin birds are commonly seen, and where many of their bowers have been located: one is built close to a roadway which, on Sundays especially, is busy with motor car traffic. Another bower is within "cooee" of a favorite picnic spot. In fact, without going far off beaten tracks, one may visit nearly a dozen play-halls of *Ptilonorhynchus* in Sydney's National Park, where all wild life is well protected.

The male satin bird in full adult plumage, attained at the age of about seven years, is very beautiful, being of a lustrous blue-black color. The eyes are violet-blue, and it is a striking fact that this species manifests a strong preference for blue or blue-tinged objects—flowers, fruits and berries, feathers, even scraps of paper. Experiments have proved this preference. Pieces of paper, cloth, or wool, of various colors have been scattered in the vicinity of bowers; and, in most cases only those of a blue or violet color, either pale or brilliant, were carried off by the birds to their playgrounds. Once, I dropped bits of orange peel at a bower and when the male bird appeared after I went into hiding, he displayed annoyance. The orange-colored objects offended his eyes, for he picked them up deliberately, one by one, and deposited them some yards away from the bower. But polished brown and yellow-brown land shells are commonly found decorating the bowers, or lying close to them. Blue feathers of the crimson rosella (*platycercus elegans*) and other parrots are frequent among the decorations, as also are blossoms of the favorite color, from Bush plants or gardens. Yellow feathers and green ones are given a place, but, in my experience, blue is ever the dominant color note, while red or orange-red is not tolerated.

The color sense of this species, then, is highly developed; it is a blue bird in more than one sense, and amazingly purposive in the decoration of its bower and the cleared space round about it.

While the structures vary a good deal in neatness, they conform to a general plan. A small stick platform first is laid down, and on this base the birds construct two arched walls of sticks, rising to a height of about eighteen inches. The walls may be rather spreading, or beautifully arched with the tops of the longer sticks touching. Again, at the top, the walls may curve slightly outwards. Degrees of skill are evident, if a number of bowers be examined. The less symmetrical bowers may be the work of young birds, apprentices to the craft; but that is mere conjecture.

The avenue in these arched bowers is, usually, about eighteen inches in length. We have watched the builders at work—a fascinating sight, you may imagine. Here, again, the satin bird is selective: it chooses long sticks or twigs, and often is particular in placing them. I have seen a bird fix a stick in the bower wall, remove

it an inch or two, fix it anew, and then be dissatisfied!

More remarkable than its color-sense, than any habit hitherto observed in birds of any species, is the satin bird's use of a "brush" and "paint" in decorative work on its bower! Long before the "brush" was noted, "painted" bowers had been recorded. One I saw had the grey sticks of its inner walls blackened from the base to a height of six or eight inches. They appeared to be stained rather than painted, but on rubbing a few sticks lightly, I had black smudges on my fingers.

Only in recent years has the satin bird's habit of painting its bower walls been observed, though there is no doubt that this unique avian "craft" is constantly practised. Even more recently, the use of a "brush" by the bird was brought under notice.

The principal material for painting is charcoal, pieces of which the bird crunches in its bill. Several observers have descrbed how the "brush" is made and used. Mr. K. A. Hindwood, an Australian ornithologist of the younger generation, on a November morning, watched the whole process at a bower in Sydney's National Park. A male bird, on three occasions, picked up pieces of fibrous bark and, rolling them in his bill, produced a wad. This was the paint-brush, and he kept it inside his bill, except once when an end of the bark protruded. Black substance oozed from between the upper and lower mandibles, and the feathered artist painted the bower walls by wiping his bill against the sticks. Some of the sticks, when examined later, were found to have a brownish substance on them, so that charcoal is not the only raw material of bower-bird paint.

Mr. Norman Chaffer, a bird photographer, in October last, from a hide close to the bower, saw a male satin bird prepare brushes and paint its play-hall. First, small pieces—two or three inches long—of fibrous bark were deposited on the edge of the platform. Then, seizing a piece by the centre, the bird gradually drew it into his mouth by a sort of nibbling action of the mandibles. This was the prelude to painting. "Each stick was carefully and unhurriedly coated. The head, held sideways, was moved up and down, the sticks sometimes being passed between the mandibles. Moisture exuding from the sides of the bill was wiped on to the sticks." (Emu, April, 1931).

The genus *Chlamydera* contains five species, one being a New Guinea bird, the others, natives of Australia. I am well acquained with the spotted bower-bird (*Chlamydera maculata*), which is widely distributed in the drier inland provinces of the eastern half of the continent. It favors the scrub and open, timbered areas, and ranges from Queensland to South Australia. This species has brown plumage spotted with white, the abdomen being of a light creamy-buff color; the flanks are barred with dusky brown, and the tail is buff-tipped. The bird's chief beauty is in the mantle of plumes on the nape of the neck, which are of a lovely rose-lilac color and opalescent.

When staying at Kulkyne, a cattle station (ranch) on the Murray River, in north-western Victoria, I was introduced to a friendly pair of spotted bower-birds. They frequented the pepper trees (*Schinus molle*), growing around the homestead, when not at their playground or away in the scrub, foraging or seeking more decorations for the bower.

Beneath a great straggling climp of boxthorn (*Lycium chinense*)—like the pepper-tree, an alien which flourishes in Australia—the bower was situated. Neatly and strongly built, its parallel walls were composed of grass stalks (inside) and sticks (exterior) fixed into the ground at varying angles. The avenue floor consisted of twigs, trampled down compactly. Around the bower, the twig platform extended, but not widely; it was larger at one entrance than the other—a main approach. A collection of bright objects was strewn and piled at either end of the bower: scores of bleached bones (including a parrot's skull and ribs and vertebrae of sheep), pieces of weather-worn glass (blue and green), a few blue feathers, five glass bottle-stoppers, many fresh, glossy leaves, some red berries—and a large pellet of lead. There were bones inside the bower, but only a few. At another playground, the decorations included over one hundred bones, some large ones, and bits of emu eggshell. Silver coins have been found among bower-birds' treasures, and even pieces of jewelry, lost in the Bush by their owners, have been recovered at a playground of the spotted bower-bird. I have heard of a silver watch being found amid the collection of bones!

Bower of a satin bower-bird in the National Park, near Sydney. At the beginning of the breeding season, the sexes meet in these curious bowers in which the males display their plumage and perform amatory antics. This species has been exhibited in the Zoological Park, and when suitable twigs were supplied, provided an interesting picture of its dexterity and skill in the construction of the bower. The food of the satin bower-bird in its habitat is almost exclusively berries and small fruits. At certain seasons, concentrated raids upon cultivated fruits by flocks of the birds have led to their decimation, through the shot-guns of the settlers. Photograph by Charles Barrett.

Consider the industry of these birds; at one bower, in Queensland, more than 1,300 bones were accumulated.

The Kulkyne birds' playground was in the vicinity of the "Isle of the Dead,"* the lonely and beautiful burial place of an extinct aboriginal tribe. The isle is really a great, flattened sand dune, with the river flowing past one side and a creek around the other. Hundreds of blacks lie buried in the sand. Some of the graves are marked by rotting logs, piled there by men who long ago themselves were buried on the isle, and in spring and early summer, the dune is alight with wild flowers.

The yellow-spotted or guttated bower-bird (*Chlamydera guttata*) is one of the little known kinds, inhabiting Western and North-western Australia, the Northern Territory, and also Central Australia. The great bower-bird (*Chlamydera nuchalis*), of North Queensland and the Northern Territory of Australia, constructs

* Bulletin, N. Y. Zoo. Soc., July-August, 1931

Fawn-breasted bower-bird in the Zoological Park. The habitat of this species is South New Guinea, Louisiade Archipelago and Cape York, in northern Australia. The bower of the fawn-breast is much larger than that of the satin bower-bird, a rather graceful structure, suited to a bird of more gorgeous plumage than its rather somber colored constructor. Photograph by E. R. Osterndorf.

bowers with arching walls about eighteen inches in height, while the avenue measures perhaps thirty inches in length, and is sixteen or eighteen inches wide at each entrance. The stick walls rise from a foundation of the same material. Decorations consist of bleached snail shells and bones, small stones (in some cases), and Bush fruits, all heaped around the entrances.

The fawn-breasted bower-bird (*Chlamydera cerviniventris*) inhabits far North Queensland, some of the Torres Strait islands, and the adjacent coastland of New Guinea. It was discovered at Cape York by John Macgillivray, naturalist on board the *Rattlesnake,* the ship of a famous voyage during 1846-50, in our tropic seas and those of New Guinea and the Louisiade Archipelago. The bower found by Macgillivray, in low scrub half a mile from the beach, near the most northerly point of Australia, was removed to the ship, and ultimately reached the British Museum (Natural History), where it was duly placed on exhibition. It measured, when discovered four feet in length and the walls were eighteen inches in height. Some fresh berries are mentioned as among the decorations. The platform was very thick and composed of thicker twigs than those forming the wide and nearly upright walls.

The bowers, of course, have no connection with nesting, beyond the courtship link, if, indeed, the play-places are used for such purposes in the mating season. Descriptions of elaborate displays, attributed to courtship ardor, have been published. I have witnessed such antics, and also have seen bower-builders enjoying "play-abouts" that obviously had nothing to do with courtship. Male birds frequent the bowers when no females are present to admire their beauty and their graceful or (in our eyes) curious activities. Nests may be built far from any bower.

Generally speaking, the nests are saucer-shaped and composed of sticks, small or large, or chiefly of fine twigs. The golden bower-bird favors bark as nest-material, and mostly builds fairly close to the ground. Other species (spotted bower-bird, and cat-birds) nest high or low, often elevated nearly sixty feet in a tree of the jungle. The satin bird's leaf-lined bowl of sticks usually is situated from forty feet to fifty feet up in a forest tree.

The eggs of some species are curiously marked. Cat-birds lay cream-colored eggs with a dull surface; those of the tooth-billed species have a greenish tinge. The satin bird's eggs also are cream colored, but blotched and streaked with cinnamon-brown and umber; there are also some markings in purplish grey. The spotted bower-bird's eggs have been justly likened to hand-painted ovals of porcelain. The shape is long oval, or inclined to oval, and the slightly glossy shell is of fine texture. On a pale greenish-yellow or creamy ground color appear light grey streaks and blotches, on the inner surface, then hair-fine streaks or lines, in umber and light sienna, zig-zagging around the shell. Finally, comes an overlay of umber markings, few, but heavier and darker than the thin streakings. The regent-bird's eggs also have hair-like markings, which might have been painted on the shell with a fine camel-hair brush; the ground color is of a light-yellowish-stone tint, spotted and blotched with olive-brown or sienna. The golden bower-bird's eggs are pure white. Clutches vary in size. The satin bird lays from two to three eggs; the spotted bower-bird, two, three occasionally; the great bower-bird, one, or two; the regent bird, two, or three occasionally.

Once upon a time, it is worth remembering, the structures due to the skill and aesthetic sense so highly developed in our bower-birds, were thought to be aboriginal cradles! At least, some of the early colonists held that opinion, according to John Gould, who declares that the bowers must be regarded "as the most wonderful instances of bird architecture yet discovered." We have learned much since the great ornithologist made known to the world the amazing bower habits of the bower-builders; but, assuredly, we do not know all the chapters of their life history, and habits as remarkable as the satin bird's "brush"-making and bower-painting may yet be revealed to patient observers.

Some Notes on the Bower-birds in the Zoological Park

Lee S. Crandall

In the preceding article, Mr. Barrett has covered the bower-birds so thoroughly and so well that I can add only confirmation through my own comparatively meagre observations.

The play-house building habits of these birds are extremely interesting; while much has been learned concerning them, other facts undoubtedly await discovery. The "painting" done by a species as well known as the satin bower-bird, first made known in 1924, is a case in point.

A beautiful pair of satin bower-birds which came to the Zoological Park, via Europe, in July, 1909, were probably the first of their kind to reach America alive. Since that time, we have never been without them, as well as various other species of the family. The male of this original pair was in the green plumage of immaturity when he arrived. But a year later, during his first molt with us, he assumed the brilliant, blue-black of the adult. Mr. Barrett makes reference to the statement that seven years must pass before this color change takes place. This claim was first set forth, I believe, by the late Dudley Le Souef, of Melbourne. We never have had a young bird of known age, so that an exact check has been impossible. I do know, however, that of the several young males we have had, none has passed his first molt here without showing color. Moreover, since all of these birds were obtained from Australian dealers, it seems most unlikely that they had reached an age of five or six years before being exported. I think most naturalists will agree that this point requires further observation.

Although this bird lived with us for over ten years, he made no attempt to build a bower, perhaps because his cage was not sufficiently large. Before his death, another adult male was obtained and placed in the large flying cage in the Bird House. In January, 1921, this second bird was seen to be piling dried leaves in two parallel rows. He was given a supply of straight, slender twigs, with which he immediately began to build a bower. By evening, it was complete, the twigs being set together so strongly that the structure could be picked up intact from the leaf-covered concrete of the floor.

Since that time, except for short gaps, we have had a bower to exhibit continuously, and many thousands of visitors have had opportunity to observe the strange ability of this bird, as well as his ludricrous courtship antics. The gaps that have occurred appear to be caused by an irregular periodicity in the builder's interest. I do no know whether or not this takes place in the wilds, but with us there are times, apparently not connected with the molt, when the bird allows the bower to become neglected. The twigs are then invariably carried off by love birds and other inmates of the aviary. These lapses usually occur between January and June, and may endure a month or even more. Since the beginning of the Australian winter comes within this period, we may find the explanation there.

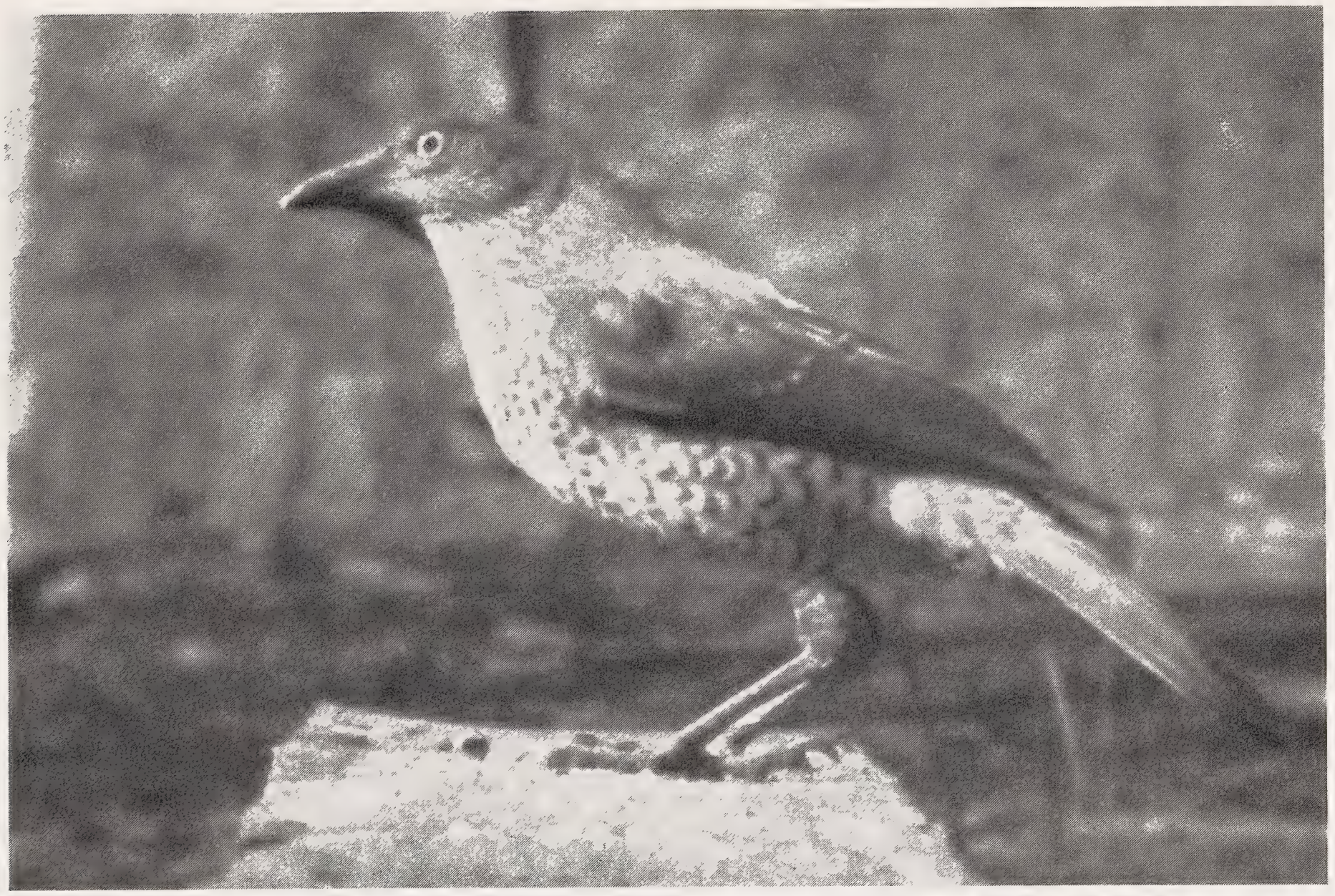
Bower-birds are not content with the mere erection of the structure but add various decorations as well. The fawn-breasted, which I observed in New Guinea, trims the platform at the front of the bower, as well as the tips of the twigs themselves, with small green berries of several kinds. The satin, as far as I know, never adds ornaments to the walls of the bower, but places them near one entrance or on the floor. He moves them about frequently, often holding one in his beak while dancing through and about the bower. Any small object will do but there seems to be no doubt that he has a decided perference for blue.

I once tried one of our birds with bits of colored yarn, hung in a row in the wire of his aviary. There were several pieces of red and of gold, with light blue in the minority. The bird took all of the latter to his bower, first, then one piece of gold. The red he would not touch. When offered small feathers, he chose first blue, then yellow, then blue-and-red. The pure red ones he would not have.

I have noticed, many times, that when the satin bird is dancing, the lovely, violet-blue eyes are invariably widely opened, even bulging. There may very well be a connection between the coloration of the eye and the shade of the ornament the dancer chooses. Our own birds make use of such playthings as they can find—usually a marble or two of blue glass (furnished by indulgent keepers!), blue feathers, even peanut shells or dried bits of fish, filched from the food tins of cage-mates. A bower of a wild bird, which I examined in the National Park, near Sydney, Australia, in 1928, contained, as ornaments, blue tail feathers of the Pennant parrakeet, some bits of blue and white crockery, a peanut shell, and several small, yellowish-green blossoms. There was nothing red.

The "painting" habit of the satin bower-bird, referred to by Mr. Barrett, is a most remark-

Upper. Bower of the fawn-breasted bower-bird. The bower proper is built on a mound of twigs, approximately four feet long, two feet wide and fourteen inches high. *Lower.* Another view of the bower-bird's playhouse. The true bower is built near the middle of the mound of finer twigs. It is about fourteen inches long, eleven inches high and ten inches wide. This bower was decorated with three varieties of small green fruits. Photograph by Lee S. Crandall, made in New Guinea.



Immature male satin bower-bird showing the plumage in an early stage of development. It has been stated by some authorities that the plumage does not attain its full color until the bird is in its seventh year. Observations made by Mr. Crandall, however, indicate that further investigation is required before the problem can be solved with certainty. Photograph by F. Lewis, Chief Inspector, Fisheries and Game Department of Victoria.

able one. In February, 1922, a keeper called my attention to the antics of a satin bower-bird, which followed him about the aviary, nibbling at the soft wood of a sieve the man was using. I watched the bird for some time, and finally discovered that the particles of wood were "chewed" until they had become thoroughly mixed with saliva, and that the resultant paste was then smeared on the twigs that lined the inner walls of the bower. A piece of dry, rotten wood was then placed in the cage and an orgy of plastering followed. When the deposit had become dry, we found that most of the inner twigs were well covered with a thick, grayish coat, of crumbly consistency. Each stick was treated separately, none adhering to its neighbor. I believe no theory in explanation of this habit has been advanced and I am unable to suggest one. There was no evidence of smearing in the bower I saw in the National Park.

In our earlier experiences with satin bower-birds in the Zoological Park, we kept male and female together. When the first bower was built, the work was done entirely by the male, the femal showing no sign of interest. After it was complete, however, I several times saw her poking about it, always during the absence of the male. On one occasion, she went so far as to pick up a loose twig and clumsily insert it, small end down, in the walls of the bower. She fled in haste when the male appeared. He made a quick examination, as though suspecting some damage, immediately spotted the offending twig and promptly removed it. No doubt the shape of the twig betrayed it, for the male seems always to set the thick end at the bottom.

It was not long after this when the male attacked his mate with such violence that she had to be removed from the aviary. We supposed this assault to have been the result of a passing whim and later returned the female to the cage. All went well for a time but one morning a keeper arrived just in time to save her again from the fury of the male. This disappointing ending of a long and laborious courtship no doubt was caused by some frustration of the completion of the cycle. We now keep only bachelor males, which seem to find sufficient amusement in the construction and care of their bowers.

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Vol. XXXV, No. 3

Contents

May-June, 1932

MODERN REMORA FISHING (Map) ..... *Frontispiece*

ANIMAL ASSOCIATIONS ..... *E. W. Gudger* 71

Symbiosis
Inquilinism
Commensalism
Parasitism

THE FISHERMAN FISH OF THE WEST INDIES ..... *C. Ralph De Sola* 75

Introduction
West Indian Remora Fishing
Historical Summary
Location of "Queen's Gardens"
Remora Fishing Today
Experimental Evidence
Conclusions
Acknowledgments

COMMENSALISM ..... *Elwin R. Sanborn* ..86-92

Illustrated with plates made at the N. Y. Aquarium

FRANK KNIGHT STURGIS: *Portrait* 94

LYDIG ARCH: *Zoological Park* 95

PICTORIAL NEWS: *Zoological Park* ..... *E. R. Osterndorff* 97-102

ITEMS OF INTEREST: *Zoological Park* 93, 96: 103-104

REMORA: *New York Aquarium* ..... *Cover*

BULLETIN

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Localities in the West Indian Region Where Remora Fishing Is Still Pursued.

The Remora or sucking-fish, *Echeneis,* used by the Caribs as a living "fish-hook" for catching fish and turtles, is pictured on the above map near the sites where this custom is used at the present time. The arrow-line from Jamaica to Cuba shows the course taken by Columbus to the islands where Remora fishing was observed and recorded for the first time in the history of man.

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Animal Associations

The Living Together of Fishes and Other Animals in Varying Degrees of Dependence

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ONE of the most fascinating subjects in the realm of nature is the living together of the lower animals by twos in varying degrees of dependence on each other on the one hand; or, on the other, in their forming socialistic communities, wherein each rank or class or caste has its set tasks as its share in the community life. We all know that the buffaloes (bisons) of North America and the antelopes of Africa go in herds for association and for protection against their enemies, that the whales and the fish of the seas go in schools drawn by the fundamental attraction of food and the equally fundamental desire to avoid enemies. But what most of us do not know is that among the lower animals are found associations between two animals generally in varying degrees of dependence from complete and perfect independence to the most complete parasitism.

Since I know most about fishes I am going to define these varying degrees of dependence, and illustrate, so far as I can, each kind with examples of what I or others have discovered among fishes.

SYMBIOSIS OR MUTUALISM

Living Together to Mutual Advantage

When two different organisms live in an association from which each gains benefit, then there is the highest type of association, one comparable to the mutualistic organization one finds among the social insects. The best known and most easily observed illustrations are: (1) the living together of algæ and fungi to form the things (not plants) called lichens; (2) the green or other colored algæ found embedded in the cells of the green hydra of fresh water, and in the cells of the sea anemones. Here the algæ take in the co_2 and other wastes given off by the cells of the hydra, break up the co_2, incorporate the carbon and mineral salts into their own cells and give the oxygen back to the hydra — a double-barrelled action covered by our term Symbiosis (*syn*—together, *bios*—life).

Symbiosis: Carangoid fish, with an attached colony of hydroids. After J. W. Fewkes.

Another fine type of association is between animals and a plant, between ants and their host plant—bush or tree. The botanist, Spruce, long ago described from the Amazon Valley the re-

AUG 22 1932

markable symbiosis between certain fierce biting ants which live in the enlarged basal cavities of the thorns found on certain trees. The tree gives the ants homes, and if man or lower animal jostles or shakes the tree, the ants ferociously attack the invader and protect their host.

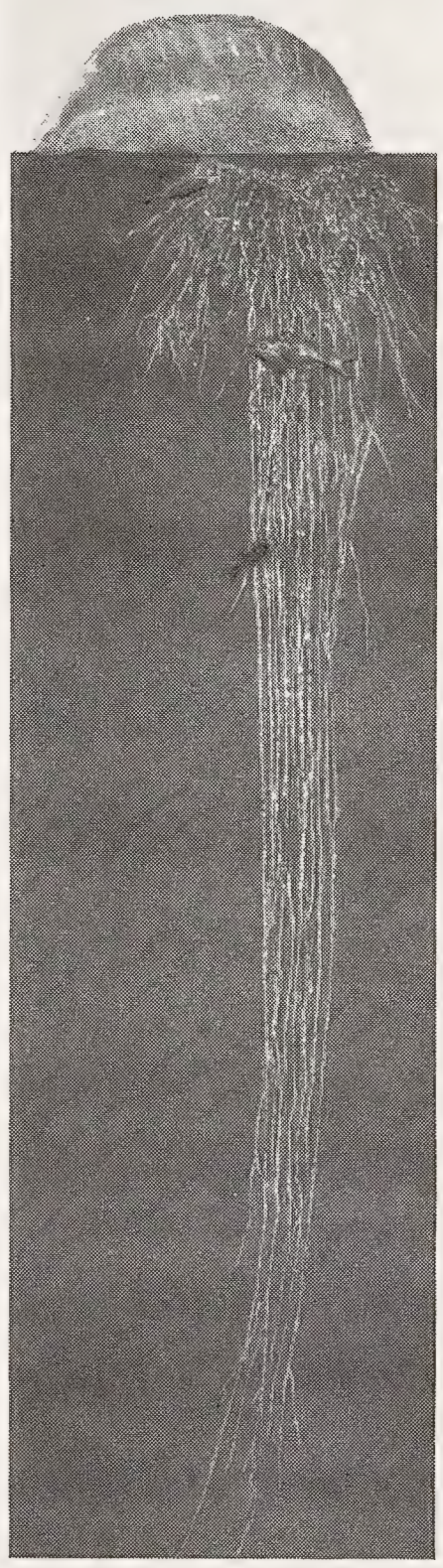
Instances of symbiosis between invertebrate animals are rather common— i. e., a sea anemone resident on the hard coat of a crab or on the sea snail shell inhabited by a hermit crab. The crabs gain a certain protection and the anemones get transport to regions where food may be more abundant. However, I can recall no case of true symbiosis between fish and fish (of different kinds). This relationship is frequently designated as that between the shark and the sucking fish or the little banded pilot fish, but if one analyzes the relationship critically it will surely fall under Commensalism.

In fact I am hard put to it to find a case of mutualism between fishes and invertebrates even. However, out of my bibliographic experience, I collected and brought together some years ago instances of marine hydroids growing affixed on to the scales and spines of fishes. These hydroids were attached to the fishes by their root-like processes, just as they would have been to a wooden or cement pile or to an iron post. Here the hydroids give the fish a certain amount of protection, and the fish translocates the colony of hydroids to fresh pastures; thus both parties to this strange association benefit, it is a case of true symbiosis.

Inquilinism
The Seeking of Lodgings

The root from which this word is derived is the Italian—*inquilinus,* a tenant, and the idea is that this tenant comes and goes without the payment of any rent. My introduction to this curious mode of life in fishes was had when I read that in 1908 a German zoologist named Plate, while resident in the Bahama Islands, had found that certain small perch-like marine fishes, which he called *Apogonichthys strombi,* lived in the mantle-cavity of the huge sea snail, *Strombus gigas,* found abundantly in West Indian waters. When I read this I became tremendously interested and wished that I could some day have the good fortune to study such an association, which the author offhandedly remarks "might easily be cleared up at the biological station [of the Carnegie Institute of Washington] at the Tortugas [Florida]."

By good fortune I was a guest at this station for several seasons beginning with that of 1912, and this problem was one in mind for study. However, since no one was studying conchs (the common name for this great snail), and since everyone was busy with his own problems and keeping our boatmen and engineers busy supplying the needs for other material, few conchs came in and none contained fish. Furthermore, these helpers, Bahama and Southern Florida-born, knew nothing of this remarkable association between fish and sea snail.



Inquilinism: Nomeus amid the tentacles of the Portuguese man-of-war. *From American Museum.*

However, by good fortune in 1914, there came to the station an investigator studying conchs. His needs brought in large numbers of these snails and I kept a sharp eye out, but not a fish relieved my anxiety. However, late in July our boat, the Dohrn, anchored off Marquesas atoll, 20 miles west of Key West, and I went with the conchologist and the men over the eelgrass flats hunting for *Strombus*. The men waded and dived in the glassy-clear water for the snails, the conchologist received them and I poled the launch along keeping up with our amphibious helpers. One great snail was laid aperture up on a seat near

me. And presently to my vast surprise I saw swimming in the water which filled the aperture a little fish. So interested and excited was I that I nearly ran the launch on a nearby coral head.

No other conchs with fishes were found but my specimen furnished the data for a short article on this curious association, which was published by the New York Zoological Society in its journal *Zoologica*. Later two investigators for the United States Bureau of Fisheries, Hildebrand and Ginsberg, found a kindred fish in conchs taken at Key West, Florida, and published their findings in the *Bulletin* of the Bureau.

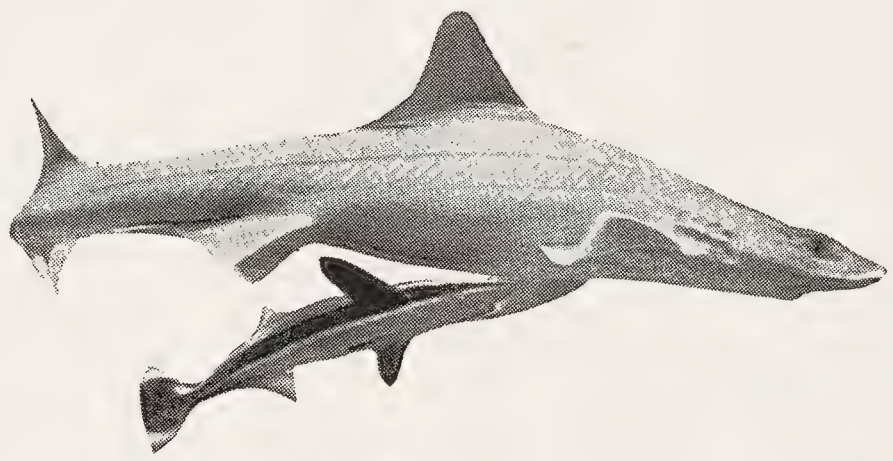
Another form of this curious habit of lodging, but one hardly on the same level, is where small fishes inhabit sponges. This, which was first described in 1917, for a fish found in a sponge off the coast of North Carolina, has been found in various parts of the world. But it was left for William Beebe to describe it most fully and illustrate it with an excellent figure in his delightful book, "Beneath Tropic Seas."

Other such tenancies are:—fishes living inside the shells of pearl oysters; inside the bodies of holothurians (sea slugs) or among the spines of sea urchins; small fishes living under the umbrellas of jellyfishes; and others living inside the bodies of huge tropical sea anemones. One might multiply instances almost indefinitely.

Before leaving this subject, it must be confessed that no explanation is at hand for these associations save that the fish find lodgings and protection. One cannot conceive that the conch or the sponge or jellyfish or sea anemone or sea slug gains anything by this—one-sided—association.

Commensalism
Living at a Common Table

On a slightly lower level is the association coming under this designation, whose derivation is from the Latin, *com*— together, *mensa* — table. Perhaps the most commonly known case of this phenomenon is the association between the echeneis or remora, the shark-sucker, and its friendly shark. This fish, as is known at any rate to zoologists, has its spiny dorsal fin converted into a remarkable sucking disk which has been translocated forward until it has come to rest in the shoulder region and on the back of the head of the fish. This elliptical disc has a circumferential rim of soft fleshy material, while extending right and left across the disc, like the slats of a Venetian blind, are cross partitions of fleshy tissue beset with fine tooth-like spines. The sucker lays this disk flat against the shark's flank and by muscular action raises the rim and slats, thus creating a partial vacuum. And thus by atmospheric pressure plus the pressure of the water the sucking-fish is held fast to the shark. Furthermore, if one pulls backward on the tail of the fish, the little spines in the "slats" stick into the epidermis of the shark and aid in the firm holding-fast.

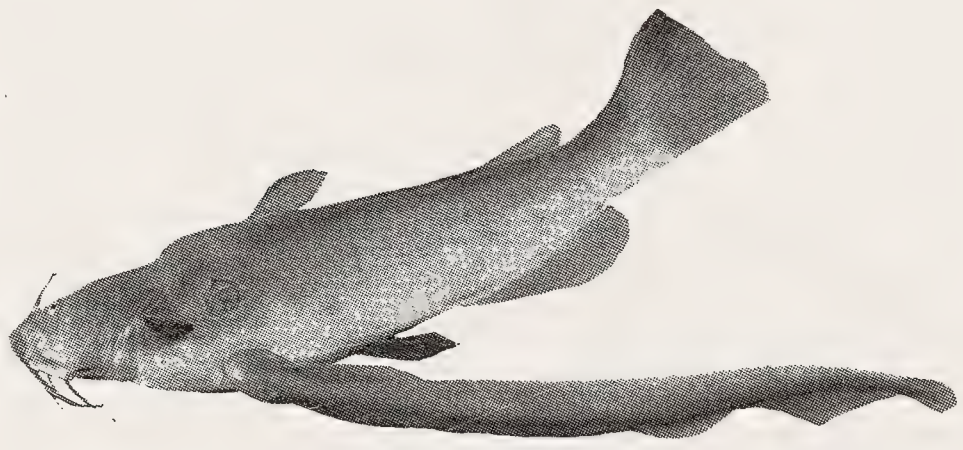


Commensalism: Shark with attached sucking-fish. When the shark seizes its prey, the *Echeneis* feeds from the fragments. *From American Museum.*

But, the reader says, "I can see that the remora gets free transportation, but what makes him a commensal with the shark, how does he eat at the same table?" In answer let us say that most sharks have sharp, pointed tearing, or broad serrated chopping teeth—and that with these they tear or cut their prey in pieces sufficiently small to pass down the cavernous gullet into the capacious maw of the shark. In this process smaller pieces are torn off and float about in the water. The remora, relaxing the muscles of his sucking disc, lets go of the shark, snaps up these fragments of food, and affixes himself again to the shark. Thus he feeds at the shark's table, without, however, taking any food that the shark cares for.

This photograph, taken in the New York Aquarium, shows in some detail the arrangement of the shark-sucker's disc. The disc functions as a sucking cup when the fish adheres to its host and by muscular action creates a partial vacuum by raising the edges of the disc. The successive transverse folds (lamellae) on the disc contain teeth which are directed backward and help grip into the surface of the host-animal, turtle, shark or manatee as the case may be.

Parasitism
Feeding on the Body of the Host



Parasitism: Cyclostome parasitic on a catfish. The parasite has rasped one hole in the fish's side and is now cutting another. *From American Museum.*

Some years ago Captain C. F. O'Keefe sent me from the Coosa River at Rome, Georgia, what he wrote were some "parasite sucking fish." When the package came I found in it seven silver lamprey eels. These parasites are called cyclostomes (Greek *kyklos* — round + *stoma* — mouth) because of their circular mouths. Within these funnel-like round mouths made of a circumferential fold of soft tissue provided with papillæ are two horny tooth-plates beset with rasping teeth. Sucking itself fast to its host-fish, the lamprey rasps through skin and scales and into the flesh where it taps the blood vessels and drains away the life of its host.

These "round mouths" are widespread and their evil habits are well known to zoologists and to the fishermen of the regions where they abound (i. e., our Great Lakes and the smaller lakes of New York state). Visitors to the Fish Hall of the American Museum have seen the display of cyclostome fishes among which is a lamprey attached to a catfish. Naturally these "round mouths" can operate better on scaleless fishes. Thus Captain O'Keefe wrote me that while he got only one "sucker" off a bass he found five attached to one catfish.

If time and space permitted, other cases might be noted. Thus I have studied the sucking and rasping mouth structures of certain very small South American catfishes which live in the gill cavities or on and in the bodies of their hosts — particularly the giant (scaleless) catfishes of those waters. Then there is the curious parasitism of the male on the female of certain deep sea anglerfishes, in which the male becomes firmly attached to a papilla of the skin of the female. In fact he becomes "grown fast" to her tissues and lives by osmosis of food materials transmitted through the tissues from her blood vessels to his.

Many such other stories might be recounted of these curious associations between fishes and other animals, ranging from the "Damon and Pythias" form of Symbiosis noted above clear down to the lowest and most repulsive forms of Parasitism. In fact a whole number of the Bulletin would hardly suffice merely to list them under their proper headings. But my intent is to incite the natural history appetite of the reader and not to satiate it, so I shall stop now and here since, as Mr. Kipling would say, each of these constitutes "another story."

Fishing with the Fisherman Fish in West Indian Waters

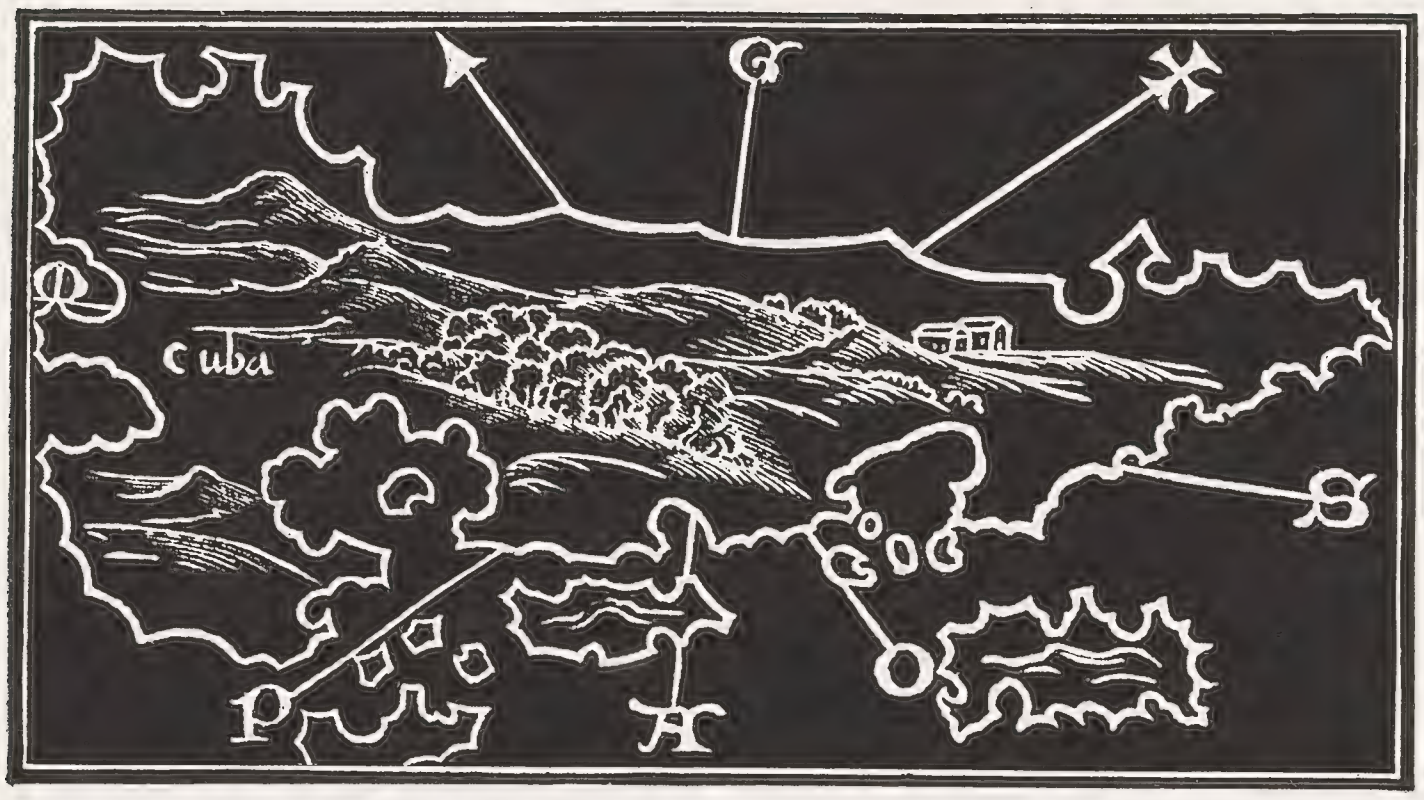
An account of the use of the sucking-fish or remora for catching turtles and fish in Cuban and Colombian waters from the discovery of America to the present day, by C. Ralph De Sola

The illustrations in this article are from photographs in the collections of the New York Zoological Society and of Dr. E. W. Gudger, who has permitted the reproduction of several plates appearing in his papers. The photographs of live specimens were made in the New York Aquarium by Dr. C. H. Townsend and Elwin R. Sanborn.

Introduction

IT is well established that fishes called remoras or shark-suckers are the hitch-hikers of the seven seas. The various species of remora, (the louse-fish or barracuda remora, the shark remora, the off-shore or turtle remora, the swordfish remora, the spearfish remora, etc.), fasten themselves to the surface of their hosts and are carried through the seas for considerable distances. Such an attachment to a shark is shown in the series of plates in this Bulletin.

This attachment is effected by means of a large, laminated sucking-disc which covers the top of their heads and which is a modified spinous dorsal fin. The shark-suckers do no



This old map of Cuba, published in 1527 by Bordoni, shows the hazy and distorted ideas concerning the New World that were prevalent among the cartographers of his time. The chart was originally intended to illustrate the location of the remora fishing incident observed by Columbus and is said to show its site, the Jardinellas de la Reina (Queen's Gardens) to the south of Cuba. Up to the present time, modern writers have been in doubt as to the exact location of this group of islands.
From E. W. Gudger after Bordoni.

harm to their hosts except to retard their motion. Transportation and increased facilities for food-getting are the desiderata of remoras.

A shark, a ray, some large bony fish, a turtle, or even a whale will answer to the first requirement—transportation. The feeding habits of such creatures as sharks, barracudas, and turtles, i.e., biting and tearing at their prey, leave much debris of the meal ready for ingestion by their hangers-on, the remoras.

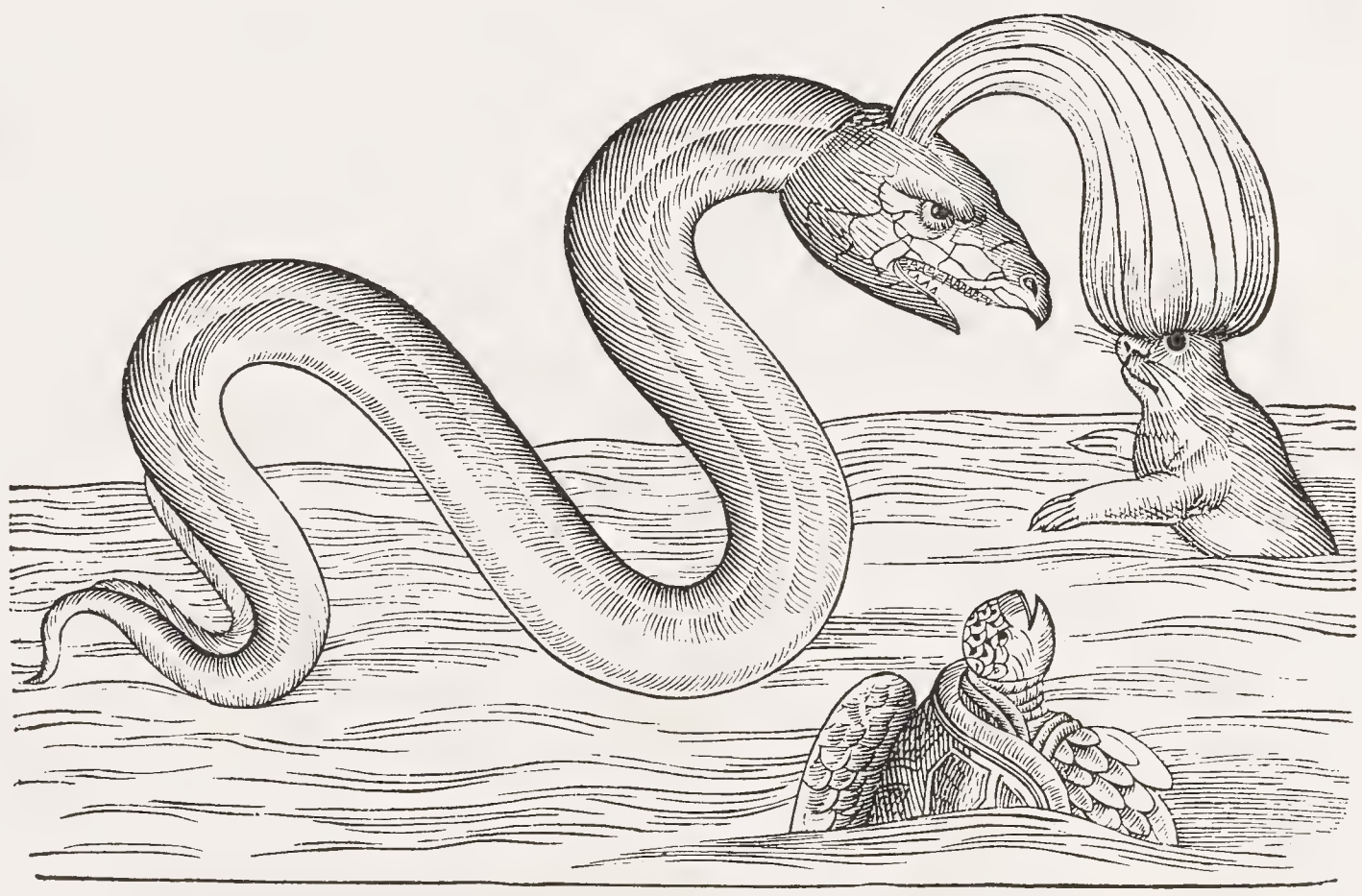
But much more interesting than the louse-like habits of these adhesive fishes, is the use man has put them to. At Cape York (northern Australia), Singapore, Zanzibar, northern South America, and Cuba, primitive man early discovered the habits of the group of discocephalid fishes and applied them for his own benefit: he fished with the remora for small marine mammals, fishes, and turtles.

The technique of remora fishing is essentially the same the world over. Professor Haddon's figure tells the story in the form of a primitive drawing made by a native of the Torres Straits region who fished with the remora and used it as his fish-hook. A former British Consul at Zanzibar, Mr. Frederick Holmwood, gives an illustration from that region showing how the remora is prepared for fishing.

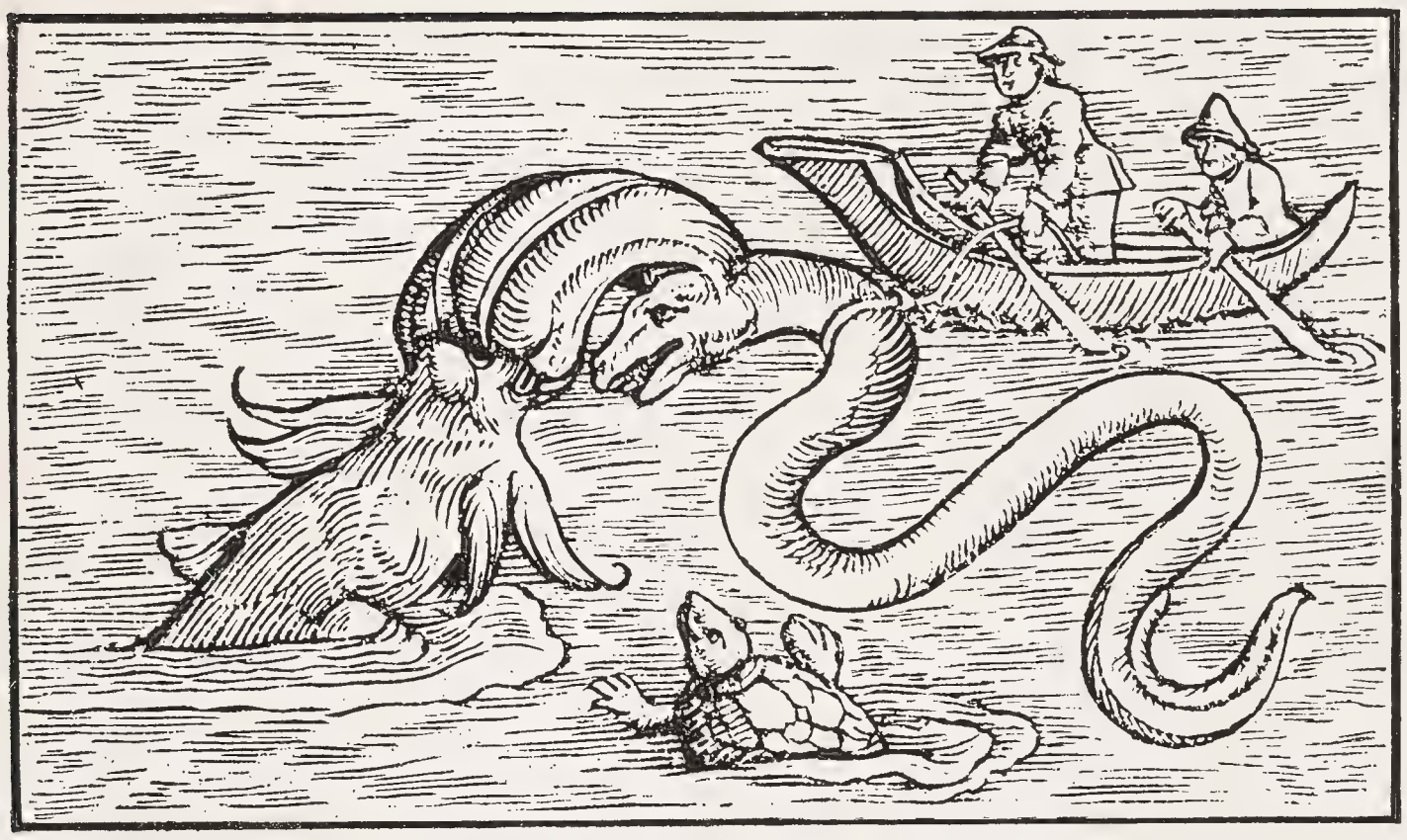
My own observations have been made in West Indian waters. The text that follows concerns itself with that region alone.

Remora Fishing in the West Indies

More than four centuries ago Christopher Columbus, on his second voyage to the New World, reported for the first time in the history of man one of the strangest and most interesting customs—that of employing a sucking-fish for fishing. Although this custom has been known and recorded in other parts of the world since that time in localities so remote as Zanzibar, Singapore and Cape York, Australia, no record of a personal observation in West Indian waters has been found from the time of its discovery in 1494 to 1885, when another tropical voyager, Lady Anne Brassey, recorded



In 1613, Aldrovandi, a famous writer on ichthyology, repeats part of Gesner's original figure. He gives some attention to the correctness of detail in the prey of the sucking-fish—the manatee and the sea turtle, but heightens and intensifies the exaggerated notions then extant of the ship-holding and fish-pursuing remora.
From E. W. Gudger after Aldrovandi.



The earliest known figure depicting fishing with the fisherman fish is from the works of Konrad Gesner, who was one of the great encyclopedists of the Renaissance. In 1558 he published this quaint wood cut illustrating Peter Martyr's account of the strange fishing custom observed by Columbus in the New World. The reversus or remora (a shark-sucker) here represented as an eel, in keeping with Martyr's account, is throwing its hood over the head of a manatee while a sea turtle looks on in amazement. The fishermen, strangely enough for Carib Indians, are dressed in the European attire of those times. *From E. W. Gudger after Gesner.*

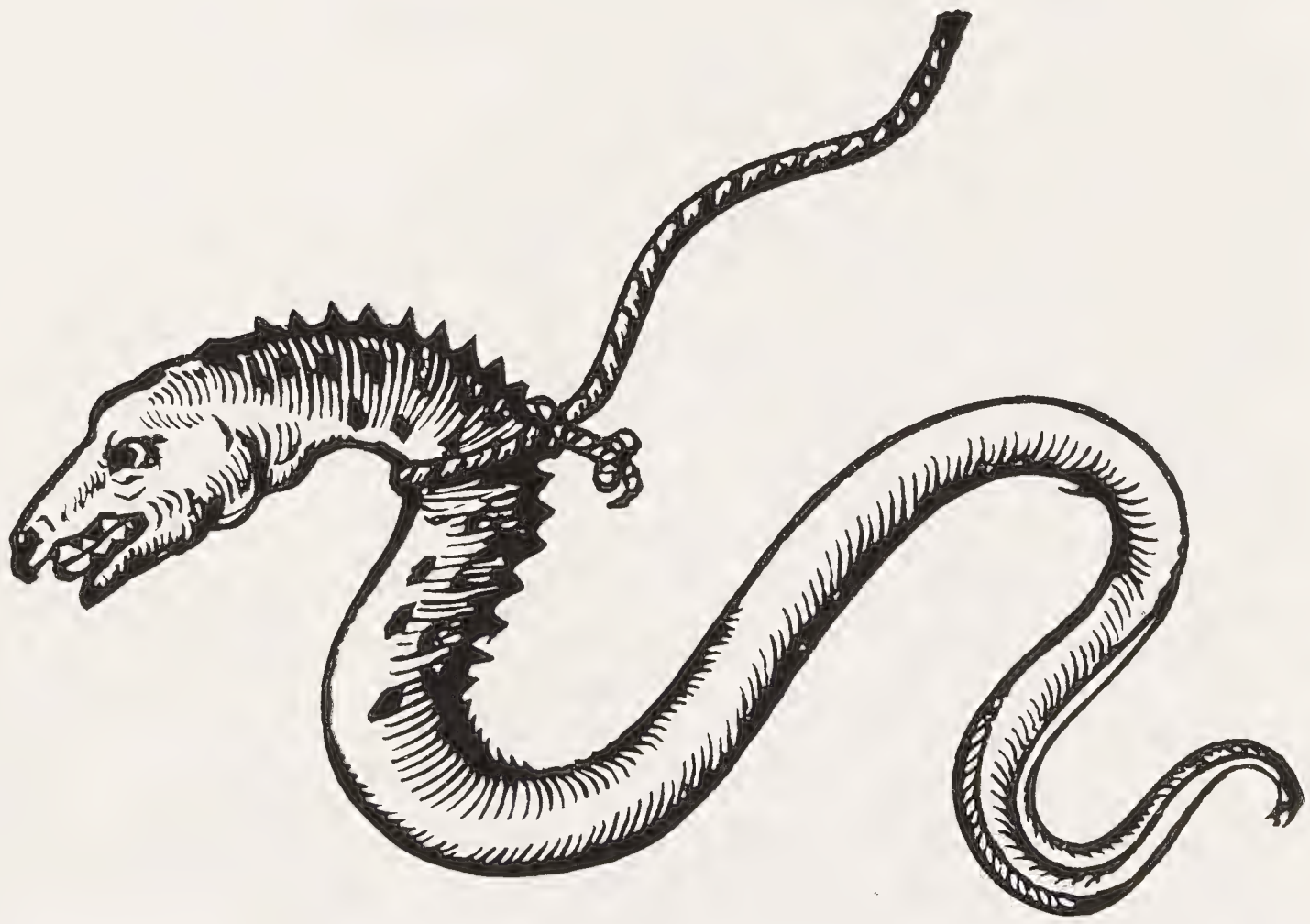
the same custom from nearby Venezuelan waters. However, in 1929, direct evidence, substantiated by personal observation, proved that the ingenious custom of a primitive people is still practised on the very site where it was first seen by the Great Admiral and that it is known today to the Indian tribes of northern South America.

Historical Summary

The principal accounts dealing with remora-fishing in West Indian waters have been collected by that indefatigable research worker in the bibliography of ichthyology, Dr. Eugene Willis Gudger, who kindly permits the use of his interesting material in this paper.

Perhaps the earliest and best written of the accounts furnished by Columbus and his crew is that of Peter Martyr, an attaché and writer in the court of Ferdinand and Isabella. MacNutt's excellent translation of his "Decades" follows:

> Everybody has assured me that they have seen fishermen use this fish just as commonly as we chase hares with French dogs, or pursue the wild deer with Mollossians. They say this fish makes good eating. It is shaped like an eel, and is no larger. It attacks fish larger than itself, or turtles larger than a shield; it resembles a weasel seizing a pigeon or still larger animal by its throat, and never leaving go until it is dead. Fishermen tie this fish to the side of their barque, holding it with a slender cord. The fish lies at the bottom of the barque, for it must not be exposed to the bright sun, from which it shrinks.
>
> The most extraordinary thing is that it has at the back of its head a sort of very tough pocket. As soon as the fisherman sees any fish swimming near the barque, he



The "Historia Naturae" published by Nieremberg, a professor in the Royal Academy of Madrid, in 1635, shows Gesner's influence except where his (or his artist's) imagination ran loose and included a saw-toothed mane on the dorsal region of the eel-like fisherman fish. This delineation was the first to appear omitting the hood described by Martyr in lieu of the sucking-disc as we know it today. *From E. W. Gudger after Nieremberg.*

Ogilby's classic, "America: Being the latest and Most Accurate Description of the New World" appeared in 1671 with this fascinating figure of his conception of the sucking-fish or remora employed as a fish-hook. Two remoras are being used in the foreground of this scene. One of them is catching a sea turtle by taking its head in its mouth. Between the palm-topped land masses of the background, the three caravels of Columbus are visible. *From E. W. Gudger after Ogilby.*

gives the signal for attack and lets go the little cord. Like a dog freed from its leash, the fish descends on its prey and turning its head throws the skin pouch over the neck of the victim, if it is a large fish. On the contrary, if it is a turtle, the fish attaches itself to the place where the turtle protrudes from its shell, and never lets go till the fishermen pulls it with the little cord to the side of the barque. If a large fish has been caught (and fishermen do not trouble about the small ones), the fishermen fasten stout cords to it and pull it into the air, and at that moment the hunting-fish lets go of its prey. If, on the contrary, a turtle has been caught, the fishermen spring into the sea and raise the animal on their shoulders to within reach of their companions. When the prey is in the barque, the hunting-fish returns to its place and never moves, save when they give it a piece of the animal, just as one gives a bit of quail to a falcon: or until they turn it loose after another fish. . . . The Spaniards call this fish Reverso, meaning one who turns around, because it is when turning that it attacks and seizes the prey with its pocket-shaped skin.

The name "reverso" really has reference to the reverse or upside-down appearance of the remora when attached to a shark or turtle. Its lower jaw extends beyond its upper jaw and unless one knows that its disc is on its dorsal surface the natural conclusion is that the fish is upside-down—hence "reverso."

Patient comparison of many accounts and figures proves the "Reverso" fish of the Spanish sailors to be the widely known discocephalid—

Echeneis, the remora or sucking-fish. Five species are known to occur in the warm waters of the West Indies and northern South America.

The fish's name, *remora,* is a word well incorporated into the Spanish language and the dictionary of the Spanish Academy lists it as of Greek origin and meaning: hindrance, obstacle, cause of delay. The sucking-fishes belong to the order *Echeneidae,* an ichthyological term taken from the Greek and meaning, *echo,* to hold; *neus,* a ship.

Location of the Queen's Gardens

The location and site of this fishing is given by Bernaldez, an Archbishop of Andalusia, who entertained Columbus and received papers and journals from him dealing with his second great voyage of discovery. In a manuscript written by Bernaldez before 1500 and treasured in the Royal Library of Madrid until 1856 when it was printed in Granada, we find the following account of the Jardinellas de la Reina (Queen's Gardens) where Columbus saw the remora-fishing that he related to his friend, Bernaldez, and that was first recorded in print by Peter Martyr as already given. "The Admiral set sail (from Jamaica) with his three caravels, and sailed 24 leagues toward the west, as far as the Gulf Buen Tiemps . . . Whitsunday, 1494."

Inasmuch as the "Gulf Buen Tiemps" does not appear on any available chart and many authors are at a variance as to the location of these islands it is appropriate to check the course of the caravels of Columbus and accurately determine the position of the first remora site known to European man.

A glance at any chart of the West Indian region leaves one with the impression that from the foregoing account Columbus arrived twenty-four leagues to the west of Jamaica and when this route is checked with dividers and parallel rules one finds a spot in the Caribbean Sea far distant from any islands. Making allowances for the discrepancies of navigation as known to Columbus, and taking into account that his maps were, at best, his own rough sketches of unmapped territory, and that he had no knowledge of the local magnetic variations or even the deviations aboard his vessel, nor of the currents and their speeds, one must reconstruct his voyage and determine what course he made to reach the islands.

Twenty-four leagues reduced gives a sailing distance of 115.2 nautical miles. Using Montego Bay, Jamaica (this being the northernmost port of that island) as a point of departure, and extending dividers to a distance equal on the Hydrographic Office chart of the West Indies to 115.2 nautical miles, the arc described will fall in the Bight of Manzanillo (Cuba) where islands called the Jardines de la Reina are located. This method gives us a course from Jamaica to these celebrated islands of 348½ degrees or North by West.

While it is true that the arc just described cuts the east end of Cayman Brac, it must be borne in mind that the Cayman Islands are a sandy and almost treeless group of three islands, while the Jardinellas de la Reina (Gardens of the Queen), as their name implies, are well wooded and consist of over four hundred cays. Bernaldez writes:

> On Whitsunday, 1494, they stopped at a place which was uninhabited—but not from the inclemency of the sky, or the barrenness of the soil—in the midst of a large grove of palm trees, which seemed to reach from the sea shore to the very heavens. . . . As the number of islands in this region was so great that he could not give each a separate name, the Admiral called them all by the common name of the Queen's Garden.

Aboard the steamer *Cananova* en route to Cienfuegos from Manzanillo, the writer passed these islands and can testify to their tropical luxuriance of foliage and to the vast numbers of royal palms that surmount the lush landscape. De la Torre and Aguayo in their Cuban Geography say (author's translation):

> From Cape Cruz to Port Casilda:—in this region of the littoral are two gulfs: that of Guacanayabo and that of Ana Maria. The coast line is low and broken up with more than 400 cays, which form, the archipelago discovered by Columbus, called the Jardines de la Reina.

It has been the impression of many writers that the islands were Hispaniola (Haiti) and Jamaica but I feel from the foregoing that no further doubt can exist as to their location being on the south coast of Cuba and within the Gulf of Guacanayabo.

Illustrations depicting remora fishing date from 1558 when Konrad Gesner, one of the great encyclopedists of the Renaissance, published in his "Liber IIII, De Piscium et Aquatilium Animantium Natura" of his great History of Animals, a figure showing this strange custom after Peter Martyr's account. The reversus or remora here represented as an eel, in keeping with Martyr's description, is throwing its hood over the head of a manatee while a sea turtle looks on in amazement. The source of this figure "IIII tabula" has been diligently sought by Dr. Gudger but never has been found.

Left: Tail of sucker-fish with band and ring. *Right:* Tail of sucker-fish with loop and servings. Methods used by the native fishermen of Zanzibar. *After Holmwood.*

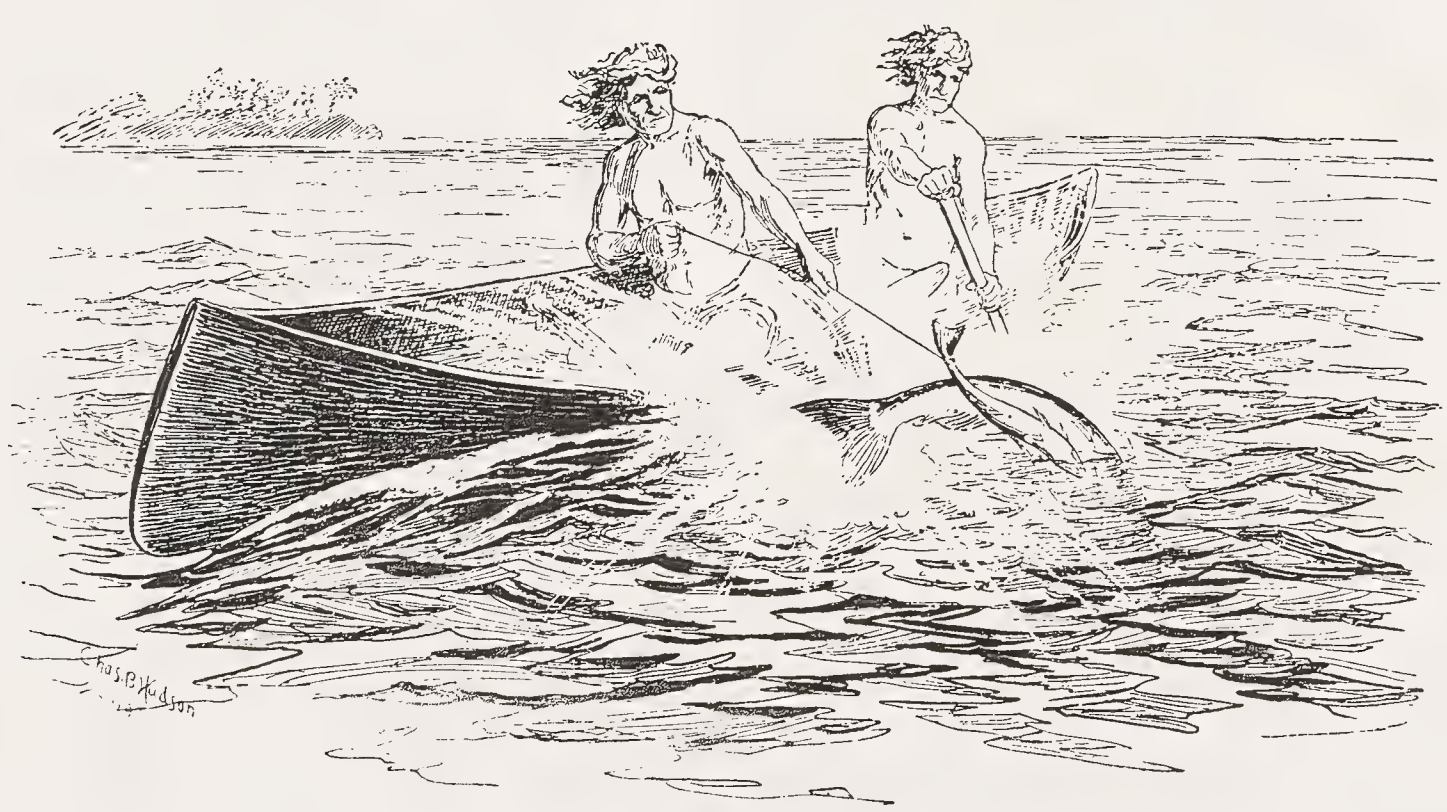
Later, in 1613, Aldrovandi, a natural history encyclopedist even greater than Gesner, repeated his figure and facts, giving considerable attention to the correctness of detail in the prey of the sucking-fish—the manatee and in the onlooking sea turtle. However, he so intensified the false notions then extant concerning the ship-holding and fish-pursuing remora that his figure today is an interesting curiosity and commentary on seventeenth century natural history.

In 1635, Juan Eusebius Nieremberg, a professor in the Royal Academy of Madrid, published in his "Historia Naturae," a delineation of the remora that was the first to omit the hood described by Martyr in lieu of the sucking-disc as we know it today.

In Ogilby's "America," which appeared in 1671, there is an illustration showing two remoras being used by Carib fishermen. One of the remoras has caught a sea turtle by taking the turtle's head in its mouth. Between the palm-topped land masses of the background, probably meant to represent the Garden's of the Queen (Jardines de la Reina), the three caravels of Columbus are visible.

The more recent writings of Hudson, Holder, and Ober, are illustrated with remora fishing scenes. The illustrations of Hudson and Ober are based on a knowledge of the aforementioned classics and are the product of their artist's imagination. On the other hand, Charles Frederick Holder, an authority on the fishes of the Florida Reef, made personal observations. His own words taken from "Stories of Animal Life" (1905) suffice to illustrate the point:—

> I experimented with the Remora but the fish invariably refused to dart after the turtle, preferring to find shelter under the boat. One tossed to a shark was seized by the latter, that doubtless thought it a votive offering. Possibly something was wrong;

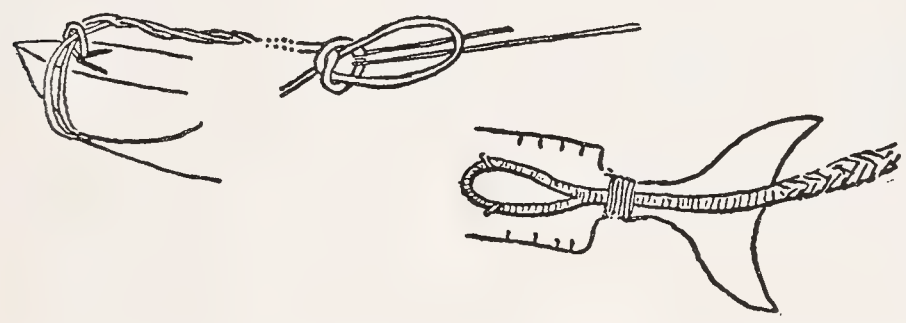


Hudson's "Curious Bread Winners of the Deep" contains this spirited picture of natives fishing with the shark-sucker, *Echeneis.* This appeared in 1893 in the Cosmopolitan magazine. *From E. W. Gudger after Hudson.*

our remoras may have been stale; they surely were not ship or turtle stayers.

Remora Fishing Today

Nearly four centuries elapsed without any mention being made of a definite remora fishing observation in West Indian waters. While it is true that such recent writers as Gosse, Hudson, Holder, and Ober have repeated the Columbus



Native drawing illustrating the method of attachment of the sucker-fish to the canoe in Torres Straits.

story of the sucking-fish in books on the animal life and natural history of this region, their works are but repercussions of the earlier tales set forth by Martyr, Bernaldez and others.

The only first hand information published in modern times comes from the pen of Lady Anne Brassey, who, in her yacht the *Sunbeam* which lay at anchor off La Guayra, Venezuela in 1885, wrote as follows:

> . . . in one of the Indian canoes which we passed we noticed a sort of sucking-fish (*Echeneis remora*), which is used in catching other fish. Arrived at the field of operations, the fisherman lets go an anchor and puts the sucking-fish, attached to a long line with a buoy at the end of it, overboard. It sees other fish at a great distance, darts after them, and attaches itself to them by means of the sucker on top of its head. The Indian easily raises his little anchor, paddles leisurely after the remora, removes the captured fish into his canoe, and repeats the operation until he has caught as many fish as he wants. Thus, one of the ugliest and most incapable-looking creatures is made by savage instinct to become of some use in procuring food for the superior animal.

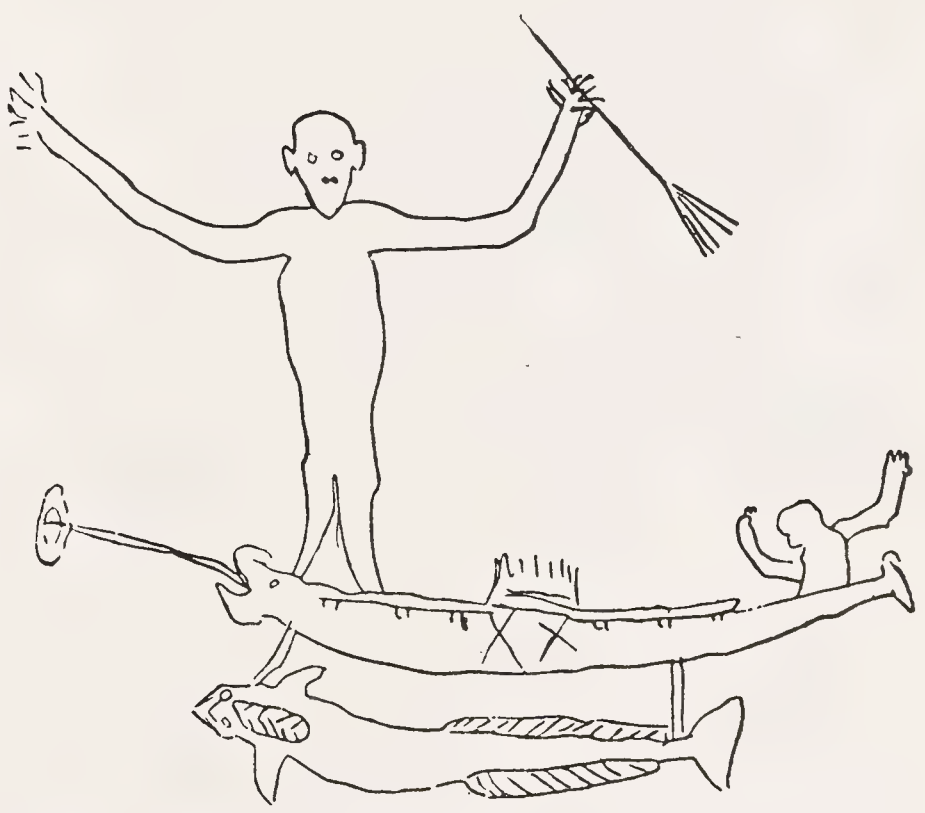
The foregoing account has been considered by many as incredible. Thirty-five years later, however, in 1920, Dr. S. De Sola, on the coast of Colombia, less than six hundred miles to the west of the adjacent Venezuelan site of Lady Brassey's account, says (personal communication):

> "On the beach at Salgar, near Savanilla (Porto Colombia), my attention was called to some native fishermen and Tubara Indians who were fastening ropes of *majagua* bark about three feet in length and from one-eighth to one-quarter inch in diameter to the tails of sucking-fish. These remoras are used to catch the edible and tortoise-shell turtles found along the coast. The custom of using these fish for fishing is restricted to a few Indians and is not widely known. This is significant as there are many fishing villages along this region of the Colombian coast."

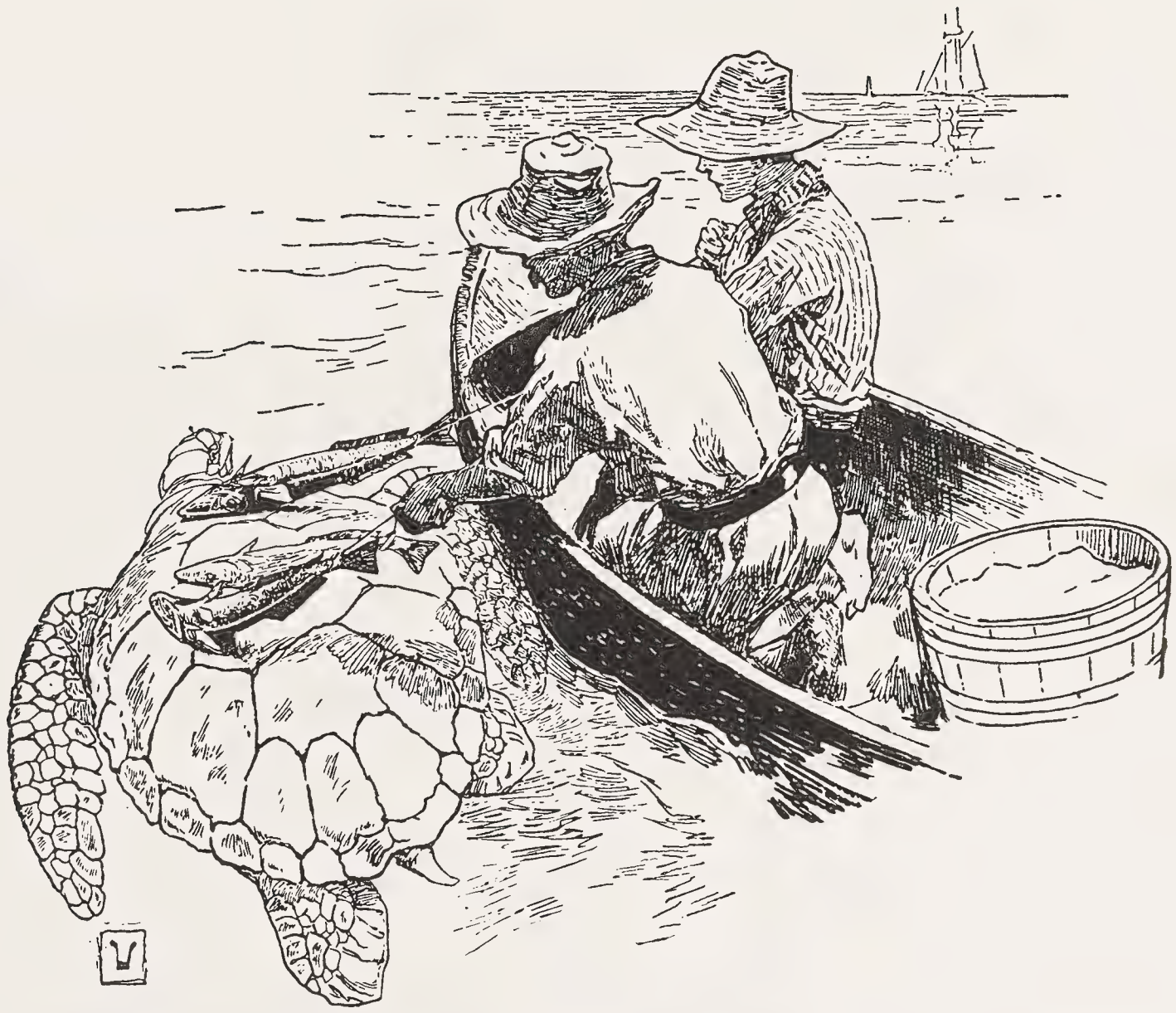
His statement should definitely confirm the existence of the custom in the seas of northern South America and thus corroborate the long disputed veracity of the earlier account written by Lady Brassey.

Observations made by the author near the first recorded site of remora-fishing in the West Indies were carried on recently while conducting some herpetological work in Cuba.

On Sunday, April 14, 1929, it was my pleasure to go on a fishing trip with the American Consul, Mr. Warren C. Stewart, and a party of Cuban friends from Matanzas. We set out from the *marina* at daybreak and motorboated



Native drawing showing how the sucker-fish is leashed by the natives of Torres Straits. In this drawing one of the natives, the canoe and the sucker-fish are represented the wrong way round. *After Haddon.*



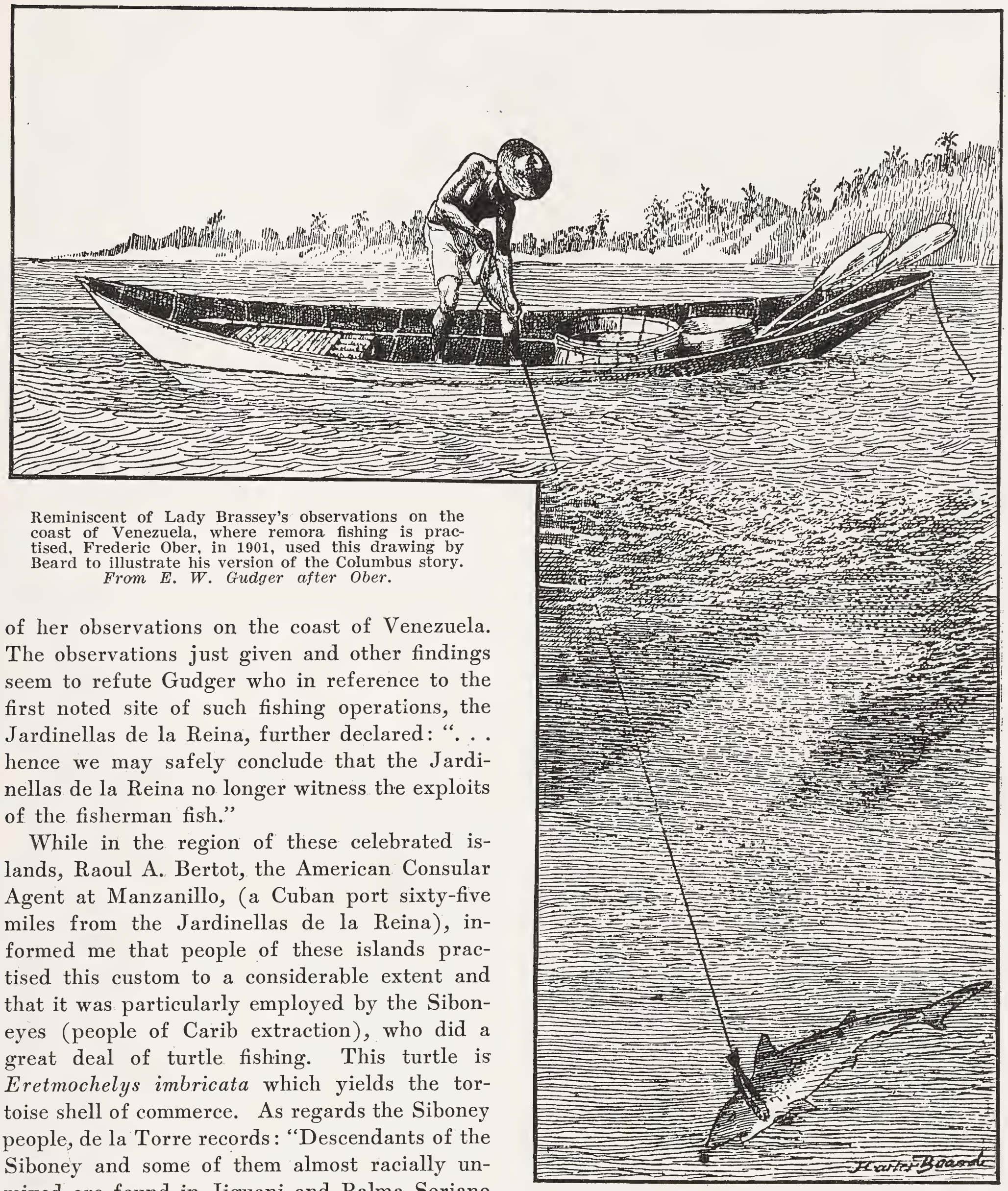
Holder, an authority on the fishes of the Florida Reef, refers to the Columbus story of the sucking-fish and gives in his "Stories of Animal Life," published in 1899, this modern figure to illustrate how the remora is used to catch sea turtles. *From E. W. Gudger after Holder.*

from Matanzas Bay to a village between that point and Cardenas. Here we got into several small carvel type row boats and went out off the sandy beaches with native crews. Along the under side of the craft a pair of *pegapegas* or *pegadores* ("stickers" as sucking-fish are called in Cuba) were attached with their discs firmly holding to the planking and a thin lanyard of *majagua* bark making them secure to the boat. This *majagua* bark is a pliable, long-fibred liana, which lends itself admirably to primitive rope making. In other parts of Cuba I saw it used as a lasso in the capture of crocodiles.

Once clear of the sandy shoal water we sighted a sea turtle basking on the surface. Our boatman immediately headed in its direction and gave us instructions to fasten the *majagua* lanyards that held the remoras to a coil of rope that was faked down in the bow. At this moment the turtle may have sensed our presence for it began to make off leisurely. The fisherman seized the sucking-fish by their heads, thus loosening their grasp from the boat; tossing them in the direction of the sea turtle which was about two points on our starboard bow, they swam rapidly in its direction. The lines ran out of the bow quickly and, using our hands as a check, we soon felt the lines go taut and the vibrations that came back indicated that our living fish-hooks were fast to their quarry. The fisherman implored us to hold tight and by no means to let the lines slacken as the tighter we held them the better the hold of the remora. We rowed up to the turtle, pulling in on our lines and found it to be a hawksbill. The fisherman made a noose fast to its neck and front flippers and with some effort we got him amidships in the boat. Once out of water, the remoras relaxed their hold on the plastron of the turtle.

The native boatman all the while indulged in much gentle talk concerning his friendship for the *pega-pegas* and reassuring them that they would be well fed and cared for on their return home. The other members of the party in their boats had the same experience except that one of them bagged two turtles during the course of the morning.

Gudger writing in 1919 stated that in the West Indian region, remora-fishing had not been recorded since 1885 when Lady Brassey wrote

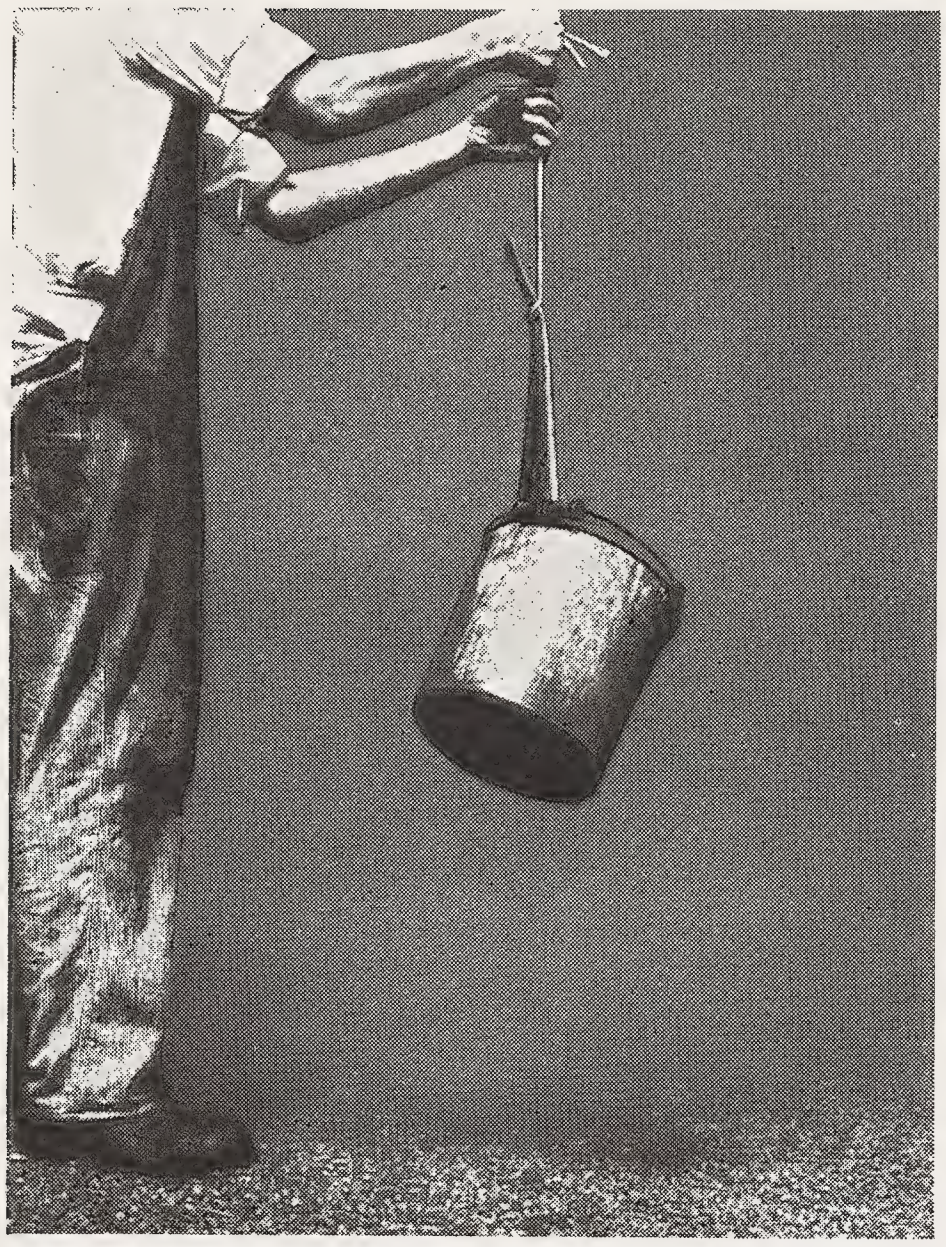


Reminiscent of Lady Brassey's observations on the coast of Venezuela, where remora fishing is practised, Frederic Ober, in 1901, used this drawing by Beard to illustrate his version of the Columbus story. *From E. W. Gudger after Ober.*

of her observations on the coast of Venezuela. The observations just given and other findings seem to refute Gudger who in reference to the first noted site of such fishing operations, the Jardinellas de la Reina, further declared: ". . . hence we may safely conclude that the Jardinellas de la Reina no longer witness the exploits of the fisherman fish."

While in the region of these celebrated islands, Raoul A. Bertot, the American Consular Agent at Manzanillo, (a Cuban port sixty-five miles from the Jardinellas de la Reina), informed me that people of these islands practised this custom to a considerable extent and that it was particularly employed by the Siboneyes (people of Carib extraction), who did a great deal of turtle fishing. This turtle is *Eretmochelys imbricata* which yields the tortoise shell of commerce. As regards the Siboney people, de la Torre records: "Descendants of the Siboney and some of them almost racially unmixed are found in Jiguani and Palma Soriano (on the Cuban Railroad between Santiago and Manzanillo), Yateras (near Guantanamo Bay), El Caney (near Santiago), and Baracoa (near Cape Maysi on the northeast coast)."

In conversation with Dr. de la Torre of the Havana University, who is the acknowledged dean of Hispanic naturalists, I was told that fishing with the remora was a hand-me-down from the Carib people and was widely practised in regions of Cuba where their descendants were to be found. The scarcity of accounts from this region is probably due to the decimation of these native fisherfolk, as the majority of Cubans are not a water loving race; in fact, all shipping is handled, operated and manned by Spanish sailors from Galicia.



Echeneis naucrates, the remora or shark-sucker, lifting a pail of water weighing 21 pounds. This experiment photographed by its author, Dr. C. H. Townsend, proves the feasibility of remora fishing.

A few interviews on the subject of the existence of the custom in Cuba follow, as by this time I was very curious to find out everything possible concerning it.

At Ensenada de Mora (Pilon), Charles Mason, sub-manager of the Cape Cruz Sugar Company, said that fishermen on Hicacos Point used the remora as their fish-hook. At Santiago de Cuba, Emilio Portuando, a local naturalist, told of the strange custom and showed a picture he had sketched depicting the fishing operation. At Guantanamo Bay (Caimanera), I was invited to go on another fishing party but time did not permit witnessing the exploits of Echeneis. These fishermen had a pair of sucking-fish secured under the stern of their row boat. The fish attached themselves with their cephalic sucking discs to the underplanking and were attached with lanyards secured to the caudal region of their bodies and made fast to the stern ring of the boat. At Nipe Bay (Antilla), George Curtis of the United Fruit Company told of the custom and showed me the fish that fished. The specimens (*Echeneis naucrates*) were alive and tethered by their tails to a fishing jetty.

Experimental Evidence

Dr. C. H. Townsend, Director of the New York Aquarium, proves the feasibility of remora fishing by the following experiments.

1. To test the holding powers of a sucking-fish he took a two-foot specimen and holding it by the tail lifted a pail with water weighing 21 pounds. A second specimen, somewhat longer was used and supported a pail with water weighing over 24 pounds.

2. A more pertinent experiment with direct reference to our West Indian custom is given in his own words:

> By way of testing its fish-catching capacity, a shark-sucker sixteen inches long was liberated in one of the tanks of the Aquarium containing fishes. It took hold at once, and by hauling on the cord fastened to its tail a good-sized grouper was brought to the surface of the water, although it could not be lifted out of the

A somewhat larger remora lifting a pail of water weighing 24 pounds. *Photograph by C. H. Townsend.*

tank. When the fish began to struggle the shark-sucker let go. When tried on a fifteen pound sea turtle, the latter could easily be drawn to the surface.

There can be no doubt that with a line attached to a large remora a much larger sea turtle could be hauled in without difficulty.

He quotes Mr. L. L. Mowbray in his article as believing that "with such weights of water as used in the above tests the fish *cannot* relax the grasp of its disk."

Mowbray's belief is sustained by the admonitions of the boatman mentioned in the Matanzas account who implored us to hold the line taut so as to help the remora. I have picked specimens out of the water and examination of the lamellae on the disc convinces me that this is not a local superstition but a physical fact.

Gudger gives a method of calculating the "pull" that a remora might withstand when employed as a fish-hook and deduces that a fish with its sucking-disc 7¼ x 2⅔ inches having an area of 13½ square inches could easily sustain a pull up to ninety-nine pounds.

Jordan in his monumental work on fishes, says:

> "The commonest species (of sucking-fish), *Echeneis naucrates,* called pega-pega or pegador in Cuba, reaches a length of about two feet and is almost cosmopolitan in its range, being found exclusively on the larger sharks, notably on *Carcharias lamia.*

The specimens used near Matanzas, Cuba, measured thirty-one and thirty-five inches in length, being of the same species mentioned by Jordan. At Cardenas, on the afternoon following our remora excursion, I saw turtles brought in from pound nets with remoras firmly attached to their plastrons and upon inquiring whether they had anything to do with the fishing I was informed that, on the contrary, the turtles were frequently taken with remoras attached to their undersides. It is well known that they also attach themselves to manatees, porpoises, large oceanic fishes and occasionally to the hulls of ships.

As regards their swimming powers Breder has an interesting comment:

> That fishes of such natatorial powers possess such a highly specialized organ as the cephalic disc is interesting for they have apparently suffered no particular degeneration of their power to care for themselves in a locomotor sense, for of course they must first catch their shark. In this connection, their square tail is of special significance as short spurts of speed are naturally requisite.

Conclusions

1. The first site of remora-fishing known to European man, the Jardinellas de la Reina, is located in the Bight of Manzanillo on the south coast of Cuba.
2. Remora are still used as living fish-hooks upon the original site observed by Columbus over four and a third centuries ago.
3. With the possible exception of Matanzas the remora fishing localities in Cuba are near or at places where descendants of the Carib people reside.
4. Thirty-five years have elapsed since observations were made on the South American coast from the time of Lady Brassey (1885) to that of Dr. De Sola (1920). The custom is probably still in existence in Venezuelan waters.
5. The fisherman-fish of the West Indies is not found exclusively on the larger sharks but is also seen on sea turtles and other large marine creatures.
6. Owing to the arrangement of the lamellae on the sucking-disc it is impossible for the remora to relax its hold when tension is exerted backward on its horizontal axis.
7. From experimental evidence and observations there can be no doubt that the remora is capable of seizing on to sea turtles of considerable size and weight.

Acknowledgements

The author wishes to express his gratitude for the critical analysis extended by Dr. E. W. Gudger, Bibliographer and Associate in Ichthyology at the American Museum of Natural History, and for the use of his negatives. Dr. C. H. Townsend, Director of the New York Aquarium has rendered similar services as well as the editor of the Bulletin, whose photographs of sucking-fish are reproduced herein.

The photographs that follow were taken in the New York Aquarium by Mr. Elwin R. Sanborn. They illustrate typical attitudes of the sucking-fish in association with the larger sharks. Special photographic lighting equipment had to be devised in order to secure these photographs. Ingenuity, patience and skill were required on the part of the photographer. The evaluation of these results is left to the reader.

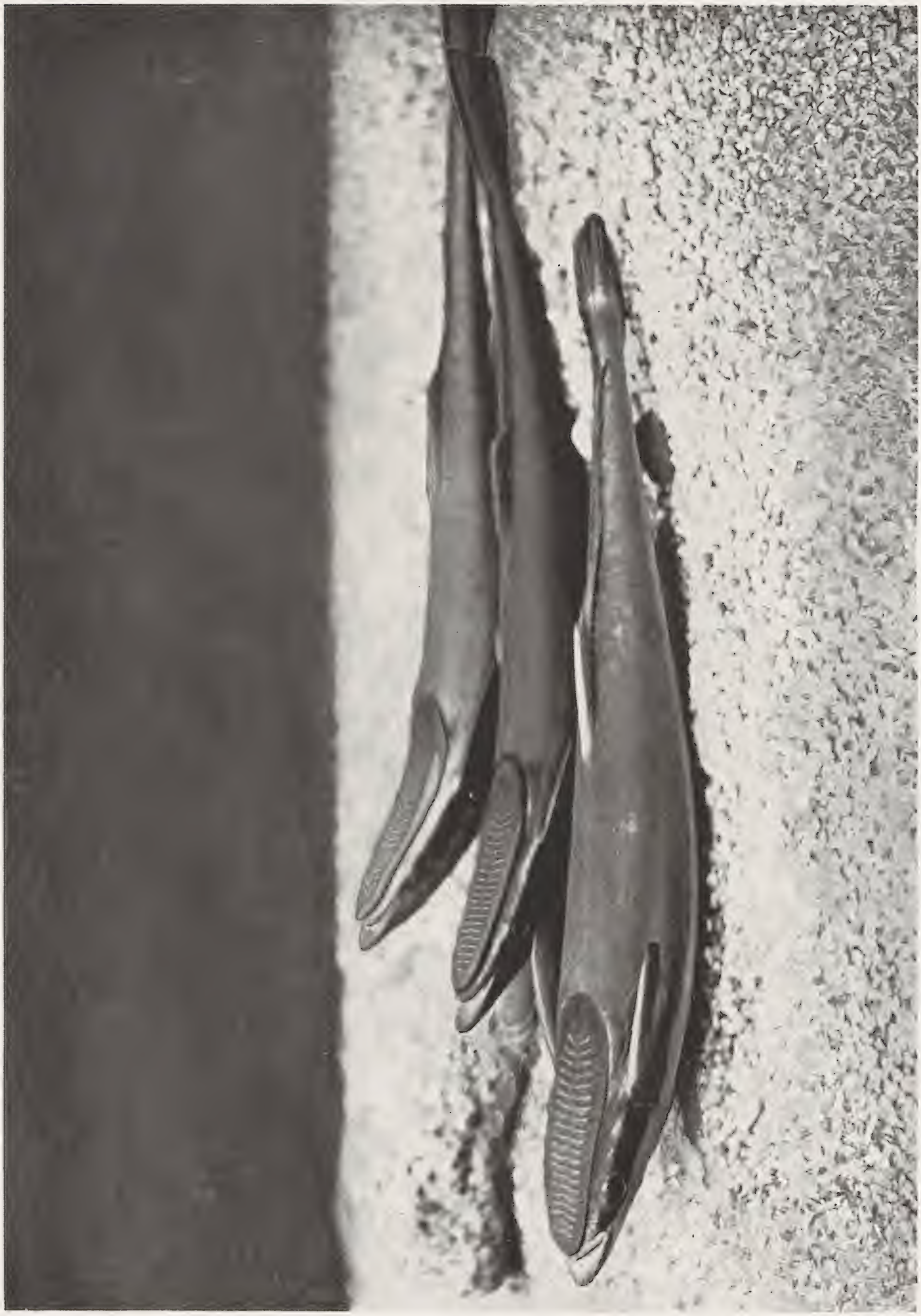
Remora attached to the belly of the large sand shark. The series of pictures illustrating this interesting companionship of two different marine forms represent a task of many nights of close application, and hours of patient waiting for the sharks to cruise into the proper position to photograph the under side. The sharp, penetrating rays of the flashlight in no way disconcerted the subject, the shark swimming on his course entirely unconcerned.

This shows the sucking-fish attached to a sand shark in one of the tanks of the New York Aquarium. This is a typical and natural group found to be common in the seas in many parts of the world.

The fisherman fish, *Echeneis naucrates*, like many other marine fishes, has the power of making instantaneous changes in its markings. In this view two color phases of the same species are shown.

The remora or sucking-fish is a commensalist and is usually found associated with the larger sharks and sea turtles. Commensalism is the term used when the lodger (in this case the remora) obtains food with the assistance of its host (the shark).

The smaller sharks, whose movements were rather swifter than the larger specimens, were not always good hosts. When they became annoyed by the drag on their speed by the attached remora, they dropped to the bottom of the tank, where the contact with the pebbles forced their unsought companion to sever his connection. Speed in swimming had no effect on the remora, but the rough drag on the floor of the tank was a certain means of discouragement.



A group of remoras photographed in the New York Aquarium showing the proportion of the sucking-disc to the entire fish. This disc is an evoluted dorsal fin. Their strong, square tails, so useful in pursuit of their host, are also shown.

Items of Interest — Zoological Park

The Snake Island: An island area, surrounded by a water-filled moat, and stocked with a variety of North American serpents, is now an important exhibit of the Park and attracting keen attention. This installation was carefully planned, both as to construction and attractiveness, and is particularly satisfactory. It is fifty feet long and twenty-five feet wide. The outside wall is of cast cement panels, of pale hue, ground to smooth finish. Interspersed with the panels are piers of special brick to conform to construction details of the nearby Reptile House. The island has grassy slopes and an elongated rock ledge, with shelving crevices. Over fifty snakes, of six species have been liberated in the area. The snakes frequently enter the water and swim about the island.

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Young Animals: The spring and early summer months have brought a number of interesting births among the mammals. Two of these have been very rarely recorded in the history of zoological collections. The exceptional specimens are a baby kudu and a brindled gnu. It also happens that both are singularly attractive types. They are also vigorous and developing rapidly. While not rare among recorded births, two of the most interesting infants in the Park are rhesus monkeys, born only a few days apart. Among the other young animals are a yak, American bison, fallow deer. Dybowsky's deer, two axis deer, three red deer, two white-tailed deer, two tahr and four aoudad.

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Nest of Galapagos Tortoise: A most unusual event occurred in June, in the yard occupied by one of our colonies of Galapagos tortoises. A one-hundred pound tortoise dug a deep nest and deposited eggs, then carefully filled the cavity and tamped it down with her shell. As far as we know this is the first record of actual observation of the nesting habits of these giant tortoises. The female concerned was one of four presented to the Park by Mr. W. K. Vanderbilt in March, 1928. Mr. Vanderbilt had conducted an expedition to the Galapagos Islands and captured the four specimens on Duncan Island. The species concerned is scientifically known as *Testudo ephippium*. There have been several indications of breeding among these specimens. Late one afternoon this larger example of the two females was seen to be busily digging until she had a cavity about two feet in diameter by eighteen inches deep. The rear portion of the tortoise tilted into the cavity and the digging was done with her hind feet, by a sweeping motion, which brought the earth to the surface. She finally came to rest in this position and as night came on and we did not wish to disturb her with artificial light, we left her to the nest building. In the morning, the cavity had been filled and shell markings indicated that she had tamped the earth firmly. A careful investigation with a trowel revealed several eggs, apparently four. We did not critically make further examination for fear of damaging the eggs, and therefore our investigating crevice was refilled. From the meager notes about eggs of smaller tortoises, we estimate these eggs should hatch about October. If we obtain freshly hatched Galapagos tortoises and have a chance to rear them, the resulting notes will be unique in the history of zoological observations.

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Interesting Arrivals: Through Mr. Ross Freeman's interest in zoological collections, an extensive series of Sumatran mammals, birds and reptiles arrived in New York, July 10th, on the Furness Withy liner, *Javanese Prince*. The specimens are being distributed among several zoological gardens, the greater number going to Washington and New York. Our portion of this shipment was composed entirely of reptiles. We received three salt-marsh crocodiles, three large monitor lizards, a twenty-foot python, three "blood" pythons, four mangrove snakes, a king cobra and a tree viper. The king cobra is about eleven feet long. The "blood" pythons, *Python curtus*, were of particular interest as the species in the past, has been extremely rare in collections, even in preserved form, in the museums. It has previously been described as of red coloration, but the specimens brought by Mr. Freeman are of yellowish hues. It is proportionately an extremely stout snake, with a small head. An example a yard long is approximately three inches in diameter.

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Growth of the Gorilla: Our young female gorilla is developing in a most satisfactory manner and is now a really impressive exhibition

FRANK KNIGHT STURGIS

IN THE PASSING OF MR. STURGIS, THE ZOOLOGICAL SOCIETY SUSTAINED A GREAT LOSS. AS A MEMBER OF THE BOARD OF TRUSTEES SINCE 1907, OF THE EXECUTIVE COMMITTEE SINCE 1910, AND AS VICE PRESIDENT SINCE 1915, MR. STURGIS' DEVOTION TO THE INTERESTS OF THE SOCIETY AND THE CHARM OF HIS PERSONALITY ENDEARED HIM TO ALL HIS ASSOCIATES. HE GAVE MOST GENEROUSLY OF HIS TIME AND MONEY TO THE WORK OF THE SOCIETY AND THE PARK, AND AS CHAIRMAN OF THE ART COMMITTEE THE SPLENDID GALLERY OF WILD ANIMAL PAINTINGS IN THE ADMINISTRATION BUILDING IS LARGELY DUE TO HIS WORK AND PLANNING.

Photograph, Underwood and Underwood.

ERECTED IN MEMORY OF
PHILIP MESIER LYDIG
AND
CATHERINE SUYDAM LYDIG
BY THEIR DAUGHTER
FLORENCE LYDIG STURGIS
A.D. 1903

THESE LANDS BECAME
THE HOME OF
THE LYDIG FAMILY
A.D. 1802
AND BY THEM THESE FORESTS
WERE PRESERVED AND
PROTECTED UNTIL ACQUIRED
BY THE CITY, A.D. 1888

INSCRIPTIONS ON THE OPPOSITE SIDE OF THE ARCH

animal. She occupies one of the commodious cages in the southerly section of the Primate House. From the time of her arrival, her inseparable companion has been a chimpanzee of approximately her age. The frequent play of these young specimens is a source of the keenest interest among our younger visitors. The gorilla is now about five years old. She arrived at the Park in October of 1928. On arrival she weighed seventeen and a half pounds. In December of 1929 she had grown to a weight of thirty-nine and three-quarter pounds, and a year later (1930) to forty-five pounds. She was weighed in July of the present year, when the scales registered her development to seventy-six pounds.

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Anthropoid Ape Records: It appears that the Park is establishing some exceptional records as to the longevity of captive anthropoid apes, of which we have reared several from extreme youth to maturity. It is indicated that sexual maturity occurs about the eighth year. Following are records from our card index, of the period we have exhibited several examples, which continue in thriving condition: Chimpanzee Susette, fourteen years; chimpanzee Fanny, sixteen years; chimpanzee Boma, seventeen years, and a female orang-utan, Gabong, sixteen years.

R. L. Ditmars.

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The Legendre Gift:—A fine and valuable collection of birds from French Indo-China, the gift of Mr. and Mrs. Sidney J. Legendre, was received at the Zoological Park on May 10, 1932. The birds were collected by the Legendre Indo-China Expedition and arrived here in excellent condition, due to the painstaking care they had received from Mr. T. Donald Carter, Assistant Curator in the Department of Mammals at the American Museum of Natural History. Mr. Carter accompanied Mr. and Mrs. Legendre on the expedition and having completed his duties in the field, could not resist the opportunity to do the Zoological Park a good turn. Included in the gift of the Legendres were two Javan peafowl, one Germain peacock pheasant, six Siamese fireback pheasants, two of the curious hybrids between the Javan jungle fowl and the domestic fowl, and a pair of the extremely rare white-winged duck (*Asarcornis scutulata*). Very few representatives of this shy and secretive duck have been kept in captivity, and none has previously been seen in this country.

In Saigon, contact was made, by the expedition, with Monsieur Jean Delacour, an Honorary Member of the New York Zoological Society. M. Delacour added to the collection a further pair of Javan peafowl, as his own gift to the Society.

At Singapore, Mr. Carter secured two pairs of great Argus pheasants, and a female Malay crested fireback pheasant, all of which he presented to the Society.

European travelers to far distant places have long made a practise of bringing home unusual specimens for local Zoological Gardens, many rare species having made their first public appearance by this means. This custom has never become as popular as it should among Americans but we may hope that the example of the Legendre Indo-China Expedition will be followed by others.

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New Birds of Paradise:—The recent purchase of three male birds of paradise—a greater, a lesser and a red—brings our collection of these lovely birds to a total of thirty-seven individuals, representing seventeen forms. Once birds of paradise have become thoroughly acclimatized with us, they usually begin their annual molt in spring, so that they are not again in full plumage until autumn. Newly introduced birds, however, may have their first molt at almost any time. At present, our older birds, including those brought from New Guinea in 1929, are in complete disarray but the two male Emperor of Germany's birds of paradise, the two males of Rothschild's gorgetted, purchased last year, and the recently arrived lesser, are all in full color. This is a fortunate chance, for birds of paradise undergoing the molt are not objects of great beauty. We do not expect these birds now in color to molt again until the spring of 1933, when all will then be on the same schedule.

—*L. S. Crandall.*

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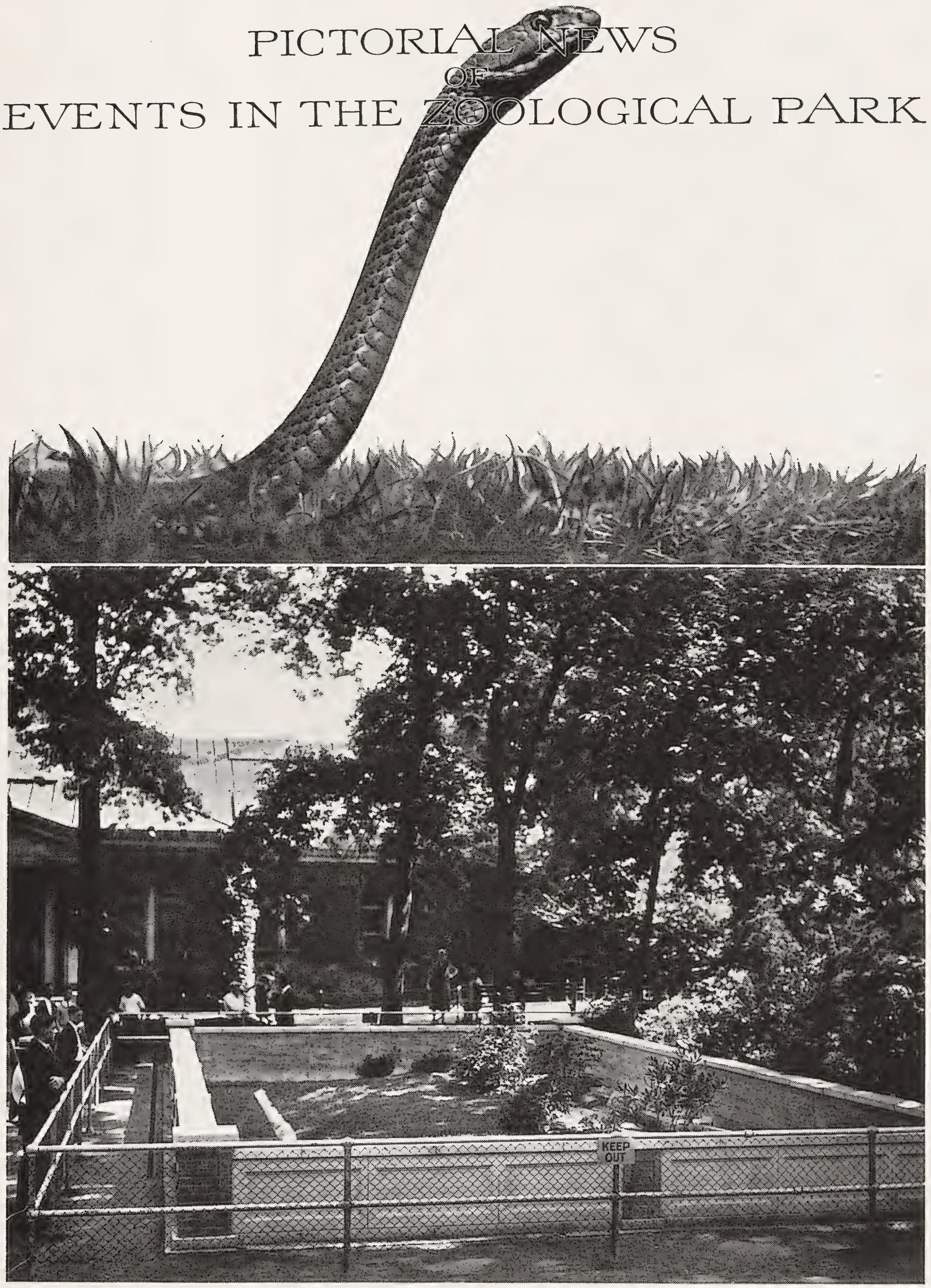
Endowment

The Endowment Fund of the Society has been increased by the bequest of $50,000, from the estate of the late Mortimer L. Schiff. This sum has been deposited in the Schiff Endowment Fund.

PICTORIAL NEWS OF EVENTS IN THE ZOOLOGICAL PARK



A new installation in the Zoological Park for the out-door exhibition of several species of harmless serpents. It has been aptly termed "Snake Island," and is briefly described in this issue.

Visitors to the Zoological Park are almost certain to have their attention attracted to our pea fowls, which have a free run of the Park, either through seeing the gorgeous display of the males or by hearing their raucous voices. Thanks to the generosity of the Sidney H. Legendre Expedition to Indo-China, and to M. Jean Delacour, we now have, in addition to our Indian and white pea fowls, four specimens of the Javan form. This species is somewhat larger than the common pea fowl, the crest is longer and the neck and underparts are green instead of blue.

The collection of zebras in the Zoological Park is an exceptionally fine one and we have been successful in raising the offspring of most of the mated pairs. To keep the herd in good condition it is sometimes necessary to secure young animals from outside sources. This recently acquired two-year-old Grant zebra thus replaces a much older animal.

This fine specimen of the chacma baboon from South Africa is the largest baboon ever exhibited at the Zoological Park. The chacma lacks the violent red and blue coloring which adorns the West African drill and mandrill, and also the colored ridges on the nose of the latter. It is fairly intelligent, perhaps more so than other baboons, and can be taught various tricks. It is the baboon sometimes seen in acts at the circus.

This brown bat was brought to the Park by a visitor as a possible addition to our collections. Less is known concerning the habits and life histories of bats than of any other group of our common mammals and they are always of considerable interest to anyone privileged to examine them in the light of day. This mother bat was of special interest because of her two young, which may be seen clinging tightly to the fur on her abdomen. The family was photographed and released.

The coati or coati-mundi is native to Central and South America. It is a southern representative of the raccoon family, and like that more familiar animal, is a tireless and industrious hunter. Coatis are gregarious and small bands thoroughly comb their territory in the search for food. This young coati is the first that we have received. They usually do not survive the sea voyage to this country.

The great ant-eater is one of the world's strangest mammals. We have been fortunate in being able to maintain this animal in captivity for a relatively long time. Our last specimen was on exhibition for eight years. Ant-eaters, in captivity, of course can not receive their natural food of ants and other insects, so a substitute has been devised. This consists of a mixture of ground meat, eggs and milk.

While North American porcupines are more or less arboreal, South American representatives of the group are climbers to an even greater degree, so much so, in fact, that they have developed prehensile tails, very similar to those possessed by the typical South American monkeys. This specimen is the spiny tree porcupine, never before represented in our collections.

The Himalayan tahr holds its own extremely well in the climate of New York City and, despite the high temperatures and humidity of the summer months, our herd has no apparent difficulty in raising the young produced on Mountain Sheep Hill. The tahr is the largest of the Himalayan wild goats. The hunting of this animal, due to the rugged type of country which it inhabits, is one of the world's most dangerous sports, although from a sportsman's viewpoint the horns are rather small.

The Zoological Park herd of yaks is famous. The original pair was sturdy and prolific. Not only were they the forebears of our present large herd, but their increase has started other herds in "Zoological Parks all the way from Boston to Melbourne." Our present herd leader is a magnificent animal, five feet high at the shoulder.

Our pair of blue or brindled gnus, acquired only last year, presented us with a sturdy young female on June 28, the first gnu ever to be born in the Park. Gnus bring all of their odd looks and much of their activities of the wild into captivity, and since they take so kindly to life in the Zoo, they make excellent exhibits.

Apparently this is the first young kudu to be born in captivity in this country. This newcomer is one of the handsomest of our young Park animals, and like in a well-marked, adult male, the perpendicular white stripes stand out strikingly from the reddish-brown ground color of the body.

The greater kudu is regarded by many persons as being the handsomest of all the African antelopes. We have always tried to have this species represented in the Park collections and several years ago we obtained a young male specimen as a mate for the female then on exhibition. On June 18 this pair bred for the first time and presented us with a fine young female.

Markhors are, after all, nothing more than goats with horns gracefully turned and spirally coiled in a cork-screw-like fashion. In the Astor markhor, the spire is open, the horns being loosely coiled. In the Suliman race, the spire is tightly closed, forming, in effect, a straight horn with spirally coiled ridges. This newcomer to the Park collections belongs to the Astor group and is native to the eastern Himalayas.

The Zoological Park herd of bison became famous in 1906, when the New York Zoological Society presented fifteen bison to the United States Government as a nucleus for the Wichita bison preserve, the first preserve designed to save the bison from extinction. Our bison herd is still vigorous and healthy. This photograph shows the latest addition to the herd.

The most picturesque animal on Mountain Sheep Hill is the Aoudad. Native to the arid and desert regions of North Africa, it nevertheless does exceptionally well in the climate of New York City. The males possess a mane of long hair on the dew-lap and an apron or pantalettes of long hair on the forelegs. Three or four young aoudads are born to the Zoological Park herd every year. Our own native mountain sheep from the Rocky Mountains find the New York climate to be utterly unsuited to them and efforts to maintain them in the Park have been so unsuccessful that we no longer try to exhibit them.

Educational work:—During the last year, the activities of this department have been concerned chiefly with extending the use of our visual instruction materials, lantern slides and motion pictures, to the public schools of the city. A modified form of docent service, in which visiting groups of students are taken behind the scenes and given a more intimate view of Park specimens and administrative details, has been used successfully, especially with groups of older children. Talks concerning the Park collections and local birds and mammals have been given upon several occasions in school and college.

During the year 744 groups of school children and other organizations visited the Park. These groups comprised a total of 27,888 children. The financial depression had its adverse effect upon these visiting groups and the number of such visitors was some 5000 under that of last year.

As reported by teachers, our lantern slides of birds and mammals have been seen by 22,393 children. One new series of slides has been added during the year—"Reptiles of the Eastern United States." This series contains characteristic photographs of reptiles of the region, and since such material is not generally available, the slides have been in steady demand.

Our motion pictures were shown to 7000 children during the year. One subject has been printed on 16mm. film and this has been so successful that more will be added as soon as possible.

The department stands ready to do whatever it can to help teachers and others in their study of natural history.—*Claude W. Leister.*

———o———

The Library: Additions to the library in recent months include a number of important and interesting books which have been acquired by purchase and by gift. Some of the volumes are to be found in the main library in the Administration Building and others have been placed in the departmental sections for the use of the Curators.

The outstanding acquisition was the purchase of a set of twelve volumes called the Smithsonian Scientific Series. The volumes contain a wealth of material based almost entirely on the collections of the Smithsonian Institution and its allied institutions. The text matter is entertainingly and authoritatively presented and the illustrations and colored plates in many cases are exceptionally fine.

Thus far eleven volumes have been issued, as follows: I The Smithsonian Institution, by Webster Prentiss True; II The Sun and the Welfare of Man, by Charles Greeley Abbot; III Minerals from Earth and Sky, by G. P. Merrill and W. F. Foshag; IV The North American Indians, by Rose A. Palmer; V Insects: Their Ways and Means of Living, by Robert W. Snodgrass; VI Wild Animals In and Out of the Zoo, by William M. Mann; VII Man from the Farthest Past, by Carl Whiting Bishop; VIII Cold Blooded Vertebrates, by S. F. Hildebrand, C. W. Gilmore and Doris M. Cochran; IX Warm Blooded Vertebrates, by Alexander Wetmore, Gerrit S. Miller, Jr. and James W. Gidley; X Shelled Invertebrates and the Past and Present, by Ray S. Bassler and others; XI Old and New Plant Lore, a symposium by various authors.

By gift the library has received a four-volume set of "Les Oiseaux de l'Indochine Francaise" by J. Delacour and P. Jabouille. Although bound in paper, the books present a fine example of book making in the matter of type and color plates. The latter are the work of H. Grönvald, who also made some of the color plates for The Pheasant Monograph by Dr. William Beebe. The text is in French.

Other gifts included the presentation by the United States Geological Survey of the imposing two-volume work by Professor Henry Fairfield Osborn on "The Titanotheres of Ancient Wyoming, Dakota and Nebraska." Prof. Osborn presented to the library a copy of his "Fifty-Two Years of Research, Observation and Publication." Further gifts by the respective authors were "Thirty Years War for Wild Life" by Dr. W. T. Hornaday and "The Physiology of the Large Reptiles" by Dr. Francis G. Benedict. Through Mr. Madison Grant, President of the Society, the library received "Conservation in the Department of the Interior" by Ray Lyman Wilbur and William A. DuPuy, and Volume XXI of "The Geographical Review."

Two other notable bird books recently purchased are "Florida Bird Life" by Arthur H. Howell of the U. S. Bureau of Biological Survey, and "Birds of Minnesota" in two volumes

by Dr. Thomas S. Roberts, Director of the Museum of Zoology of the University of Minnesota. Both volumes are illustrated by fine color plates and present in a very comprehensive manner the bird life of the states mentioned.

Not technical in character but containing much information of interest and value is C. Emerson Brown's "My Animal Friends," having to do chiefly with the animals in the Philadelphia Zoological Gardens, of which Mr. Brown is Director.

While the Zoological Society's library is used chiefly for reference and research purposes, it is open to members of the Society. Those wishing to avail themselves of the privilege should make inquiry of the Director's secretary regarding the rules governing the use of the books.

——o——

Accessions: The collections of the Zoological Park are added to by purchase, by births, by gifts, and occasionally by exchange with other zoological parks or gardens. The purchases are important from the standpoint of the monetary value or the rarity of the specimens acquired, the births are always interesting, and the gifts are appreciated and acceptable.

Because of the present economic situation the Zoological Society has adopted the policy of not expending any large sums on the purchase of animals except when a specimen may be needed to fill a gap in the existing collections. The only important purchases within recent months have been an unusually large chacma baboon, a female Grant zebra shipped direct from Nairobi in South Africa to New York by way of Rotterdam, and a young Astor markhor, a species which has not been represented at the Park for many years.

The most important addition to the bird collection was the purchase of three birds of paradise, one Greater, one Lesser and one Red, making the present collection of birds of paradise in the Zoological Park superior to any to be found anywhere.

The additions to the reptile collection were the most numerous and consisted chiefly of the common snakes, turtles and tortoises.

The earliest births to be recorded for the year 1932 were two aoudad which arrived early in February. By far the most interesting births were two rhesus monkeys, one in April, the other in May. The father, two mothers and two babies live amicably in the same cage. The babies have developed splendidly and it affords a most entertaining spectacle to watch their playful antics and to observe the patient care and solicitude of the two mothers for their respective offspring.

Another giraffe baby made its appearance in March, but unfortunately an infection which apparently was present from birth brought about the untimely death of the calf after only two weeks. This was the fifth giraffe to have been born in the Antelope House.

On Mountain Sheep Hill two more aoudad lambs were born later in the spring as well as a mouflon and six Himalayan tahr. The gamboling lambs and kids appear to enjoy their home on the rocky hillside.

In the deer ranges one white-tailed, one Dybowski, one Barasingha, two fallow, three red and four axis deer fawns have increased the deer population to that extent during the first six months of the year.

In the Antelope House a number of unusual animal babies have been born in the past. Aside from the giraffes this building has been the birthplace of anoas, nilgai, blackbucks or Indian antelopes, and in June of this year a kudu and blue gnu were added to the register of births. Both little animals are growing nicely and it is hoped that they may be reared to maturity.—*Edith H. Franz.*

——o——

New Members of the New York Zoological Society

Elections from January to July, 1932

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T. Donald Carter

Fellow

James P. Chapin

Changed from an Annual Member to Life Member

Mrs. George A. Helme

General Information

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee of the Society

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

Publications

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Technical and generally taxonomic description. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Irregular. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Technical and generally taxonomic description. Volume I completed. Volume II in preparation. Irregular. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society; devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-four volumes completed. Volume XXXV in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the collection of Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Publication temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. 21 editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
View of Park: Book; 24 pp. 75 color ills.
Post cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park (*out of print*).
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Pheasants: Their Lives and Homes (Beebe); 2 vols. 4 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

For all publications, other than those referring to the Aquarium or Aquatic Life—address: H. R. Mitchell, *Manager, 185th St. and Southern Boulevard, New York City.*

Guide Book: Official guide to the Aquarium collections (Townsend). Profusely illustrated, three editions issued. Published as needed.
Sea Shore Life (Mayor); 181 pp. 119 ills. Out of print. To be re-issued.
Cultivations of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Sea (Townsend); 17 pp. 21 ills.
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger); (*out of print*).
Gaff-topsail Catfish (Gudger); 45 pp. 12 ills.
Galapagos Tortoises (Townsend); 82 pp. 45 ills.
Locomotion of Fishes (Breder); 138 pp. 45 ills.
Marine Fishes (Nichols-Breder); 192 pp. 263 ills.
Fishes in the Home (Mellen); 178 pp. 63 ills.
The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs. In boards.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs. In boards.

For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Manager, Zoological Park, 185th St. and Southern Boulevard, New York City.*

NEW YORK ZOOLOGICAL SOCIETY

VOL. XXXV, No. 4 July-August, 1932

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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Vol. XXXV, No. 4.

Contents

July-August 1932

FLAMMEO; TUAMOTU ISLANDS.....(Color Plate) *Frontispiece*
FISHES FROM PACIFIC CORAL REEFS.....*C. H. Townsend* 107
EAST INDIAN REEF FISHES.....*C. M. Breder, Jr.* 121
BREEDING OF BEAU GREGORY.....*C. M. Breder, Jr.* 121
GALAPAGOS TORTOISES IN BERMUDA.....*C. H. Townsend* 121
DESTRUCTIVE FISH PARASITE.....*R. F. Nigrelli* 123
BREEDING OF BULLHEADS.....*C. M. Breder, Jr.* 129
AQUARIUM NOTES.....*C. H. Townsend* 131
"KAMONGO"; LUNG FISH.....*C. H. Townsend* 134
EARLY ACCOUNT OF WHALE KILLER.....*C. H. Townsend* 134
PORTRAIT OF HOLBROOK.....*C. H. Townsend* 137
NOTES; PARK AND AQUARIUM..... 139

Illustrations

Vincent Astor
The Nourmahal
Pacific Trigger Fishes
Yellow-striped Snappers
Reef Fishes; South Seas
South Sea Groupers
South Sea Groupers and Crab
Galapagos and Tahiti Grouper
Tahiti Fishes
South Sea Fishes
Lobsters
Sea Turtles
Beau Gregory
Fish Trap
Galapagos Penguin
Aquarium; Interior and Exterior
Development; Fish Parasite
Bullheads
Electric Eels
Golden-tail
Cubbyu
Barracuda
African Lungfish
John Edwards Holbrook
Fur Seal; Model
Gorilla Chart

THE NOURMAHAL.....Photograph by Morris Rosenfeld *Cover*

BULLETIN

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Editorial and Subscription Offices, Zoological Park, New York City, Elwin R. Sanborn, Editor.

FLAMMEO

FROM FAKARAVA, TUAMOTU ISLANDS. THE PARTICULAR SPECIES OF THE GENUS *FLAMMEO* HAS NOT YET BEEN DETERMINED. WE OBTAINED SPECIMENS OF *FLAMMEO SAMMARA* WHILE WITH THE *U.S.S. ALBATROSS* AT MAKEMO IN THE TUAMOTUS IN 1899. IT MAY BE THE SAME. THE NATIVE NAME IS NOT AVAILABLE, BUT IT BELONGS TO THE GROUP KNOWN AS SQUIRREL FISHES IN THE TROPICAL ATLANTIC. THE COLOR PHOTOGRAPH WAS MADE IN THE AQUARIUM BY MR. B. R. SHERWOOD.

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY

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Fishes from Pacific Coral Reefs

CHARLES HASKINS TOWNSEND

Illustrations made from photographs taken in the New York Aquarium by S. C. Dunton, unless otherwise noted.

WHEN Mr. Vincent Astor's yacht, *Nourmahal,* returned from the Galapagos Islands in 1930, she brought to the Aquarium a large collection of fishes, many of which are still living. Mr. Astor recently made important additions to the exhibit of Pacific fishes. This year he took the *Nourmahal* far beyond the Galapagos to the Marquesas, Society and Tuamotu Islands.

The first collection was noteworthy, as 265 fishes reached the Aquarium after a 3000-mile voyage—the longest one for live fishes in our experience. The journey made by the second lot broke all records, eighty-six fishes arriving alive after a voyage of more than 6,000 miles.

The carrying of this sort of live stock is not a simple matter of freight transportation as the uninformed person might suppose. Fishes must not only be carried in a plentiful supply of their natural element, but the water in the tanks must remain pure at all times. This means the operation of electric pumps and a flow of sea water day and night, to say nothing of mechanical aeration in the fresh water of the Panama Canal where sea pumps could not be used. Daily feeding is necessary, lest hungry fishes harass each other. When a gentleman undertakes a troublesome job, such as transporting live fishes, for the benefit of the public, it is a pleasure to assure him that the act is appreciated.

The *Nourmahal* called at Cocos Island and the Galapagos, making some additions to the list of fishes secured in 1930. The balance of the collection was secured at Nukuhiva in the Marquesas Islands, Tahiti and Bora Bora in the Society Islands, and at Fakarava in the Tuamotu Islands.

Most of the fishes were taken in wire fish traps of the pattern used by fishermen in Florida and the West Indies. The writer became acquainted with Pacific coral reef fishes at these same localities many years ago during the oceanographic investigations of the U.S.S. *Albatross.* The fishes then secured are in the National Museum at Washington in the unattractive form of alcoholic specimens. It is delightful to renew acquaintance with them as living things here in New York.

These fishes from the tropical Pacific are fascinating creatures with their amazing colors and odd shapes. Since their arrival in April, more than a million visitors have enjoyed seeing them.

Mr. Astor states that Chief Officer Carlson gave the collection his personal attention while it was on the *Nourmahal,* and Captain Klang and officers and crew participated in making a success of the effort. We personally observed, during the first voyage, the fine spirit with which things are done on board the *Nourmahal.*

Our photographer has been so successful in making pictures of these new occupants of the tanks, that many are presented in this number of the BULLETIN for the benefit of persons who have not yet seen them.

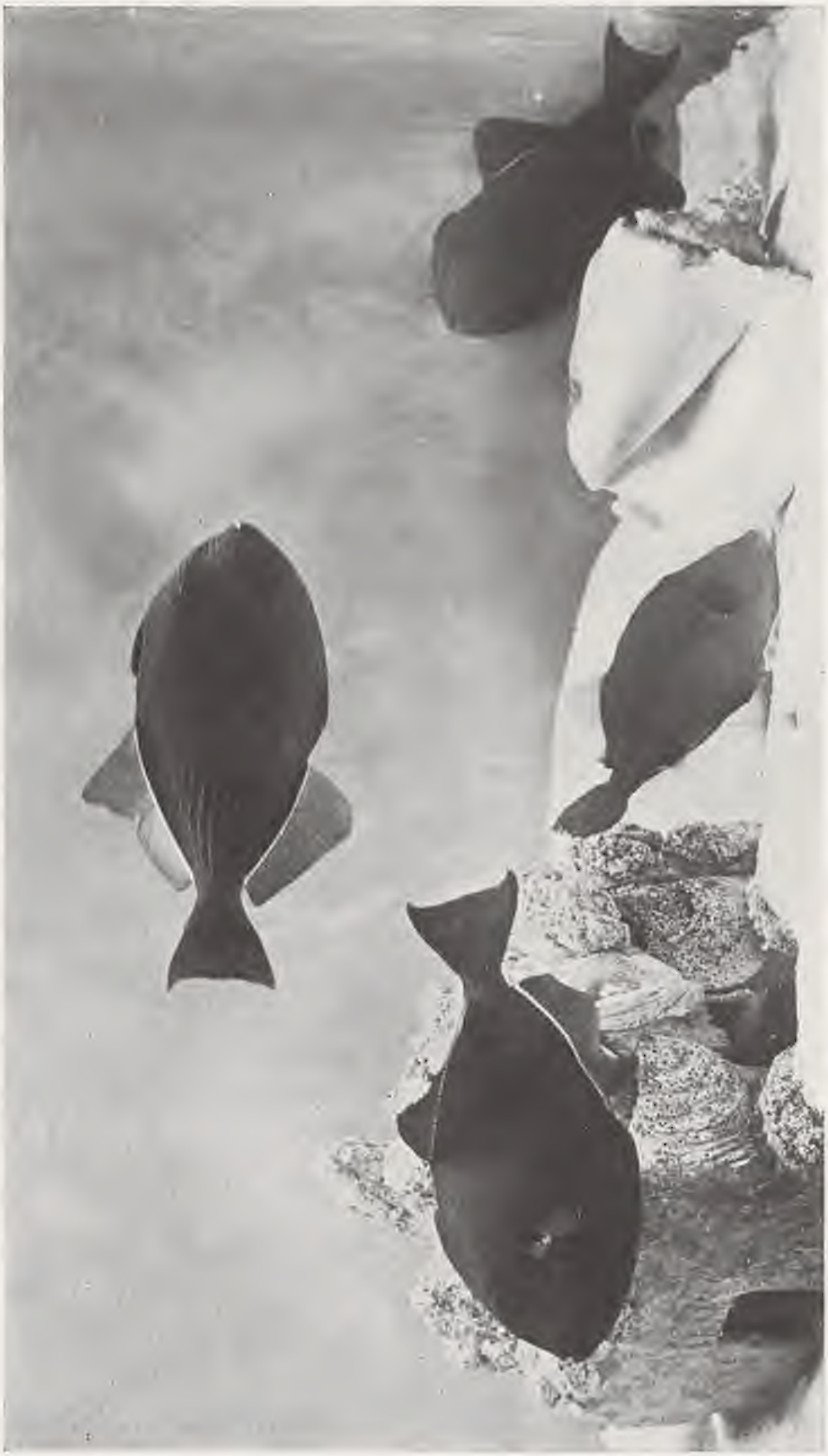
NOV 2 1932

MR. VINCENT ASTOR, OWNER OF THE *NOURMAHAL,* HAS RENDERED MUCH VALUABLE SERVICE TO THE AQUARIUM IN THE MATTER OF OBTAINING MARINE SPECIMENS FROM DISTANT LOCALITIES. HE IS NOW A MEMBER OF THE BOARD OF TRUSTEES OF THE NEW YORK ZOOLOGICAL SOCIETY.

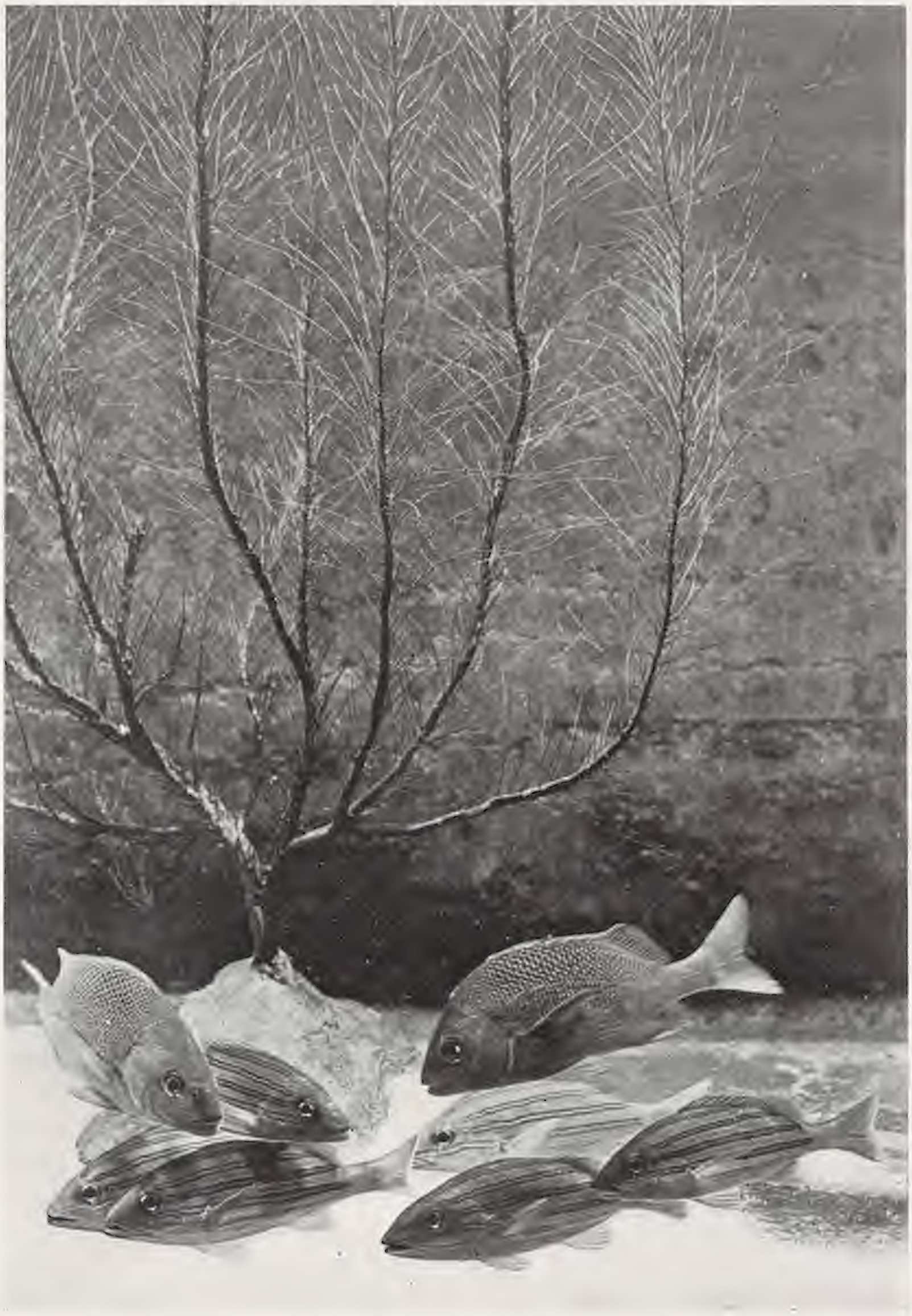
From a photograph by Blank and Stoller, Inc.

THE *NOURMAHAL.* A SHIP WHICH HAS BROUGHT MANY BEAUTIFUL THINGS TO THE AQUARIUM. THE VESSEL HAS RECENTLY BEEN FITTED WITH SEVERAL METAL TANKS FOR THE TRANSPORTATION OF FISHES AND OTHER MARINE FORMS OF LIFE.

From a photograph by Morris Rosenfeld.



Two Pacific species of Trigger Fishes; *Melichthys radula* and *Balistis* sp. Lower right. The first mentioned species is nearly black for most part but brilliantly marked along the bases of the dorsal and anal fin, with a scintillating "electric" blue line. They are particularly hardy fishes; most of those brought from the Galapagos Islands in May 1930 are still living.



Yellow-striped snappers, *Evoplites viridis,* and Grunts *(Haemulon),* from Cocos Island.

An assortment of reef fishes from the South Seas. These have been taken near and about Tahiti by the second *Nourmahal* expedition.

South Sea Groupers: *Cephalopholis argus* (rear); *Epinephelus* (front).

A peculiar "eyed" crab from the South Seas, and two Groupers: *Cephalopholis argus* (rear); *Paralabrax maculatofasciatus* (front). The real eyes of the crab are between the two conspicuous spots which resemble eyes. This crab is from Tahiti, Society Islands.

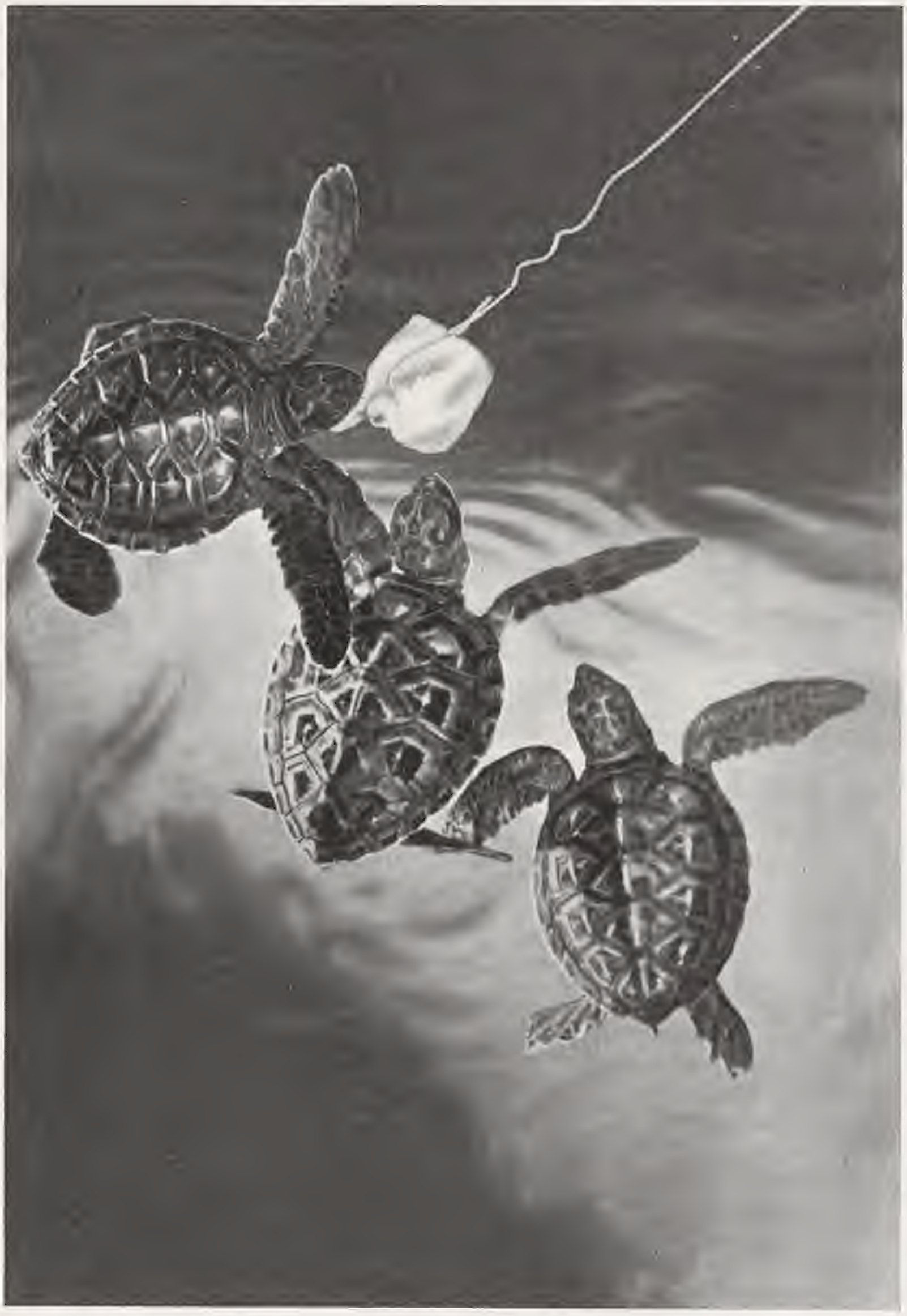
A Galapagos and a Tahiti Grouper: *Epinephelus* sp. from Tahiti (rear); *Paralabrax maculatofasciatus* from Galapagos (front).

Two Tahiti fishes: *Balistipus aculeatus* (upper); *Lutianus* sp. (lower). The *Balistipus* is found in many parts of Polynesia. From a photograph by P. W. Kearney.

A group of South Sea fishes. *Flammeo* (two fishes center); *Holocentrus* (extreme upper left); *Myropristes* (upper left). The three preceding species are all brilliant red for most part. *Xesurus* (lower center); *Chaetodon setifer* (center right rear); *Epinephelus* sp. (lower right).

Locust lobster *(Scyllarides)*, from the Galapagos Islands. Possibly an undescribed species.

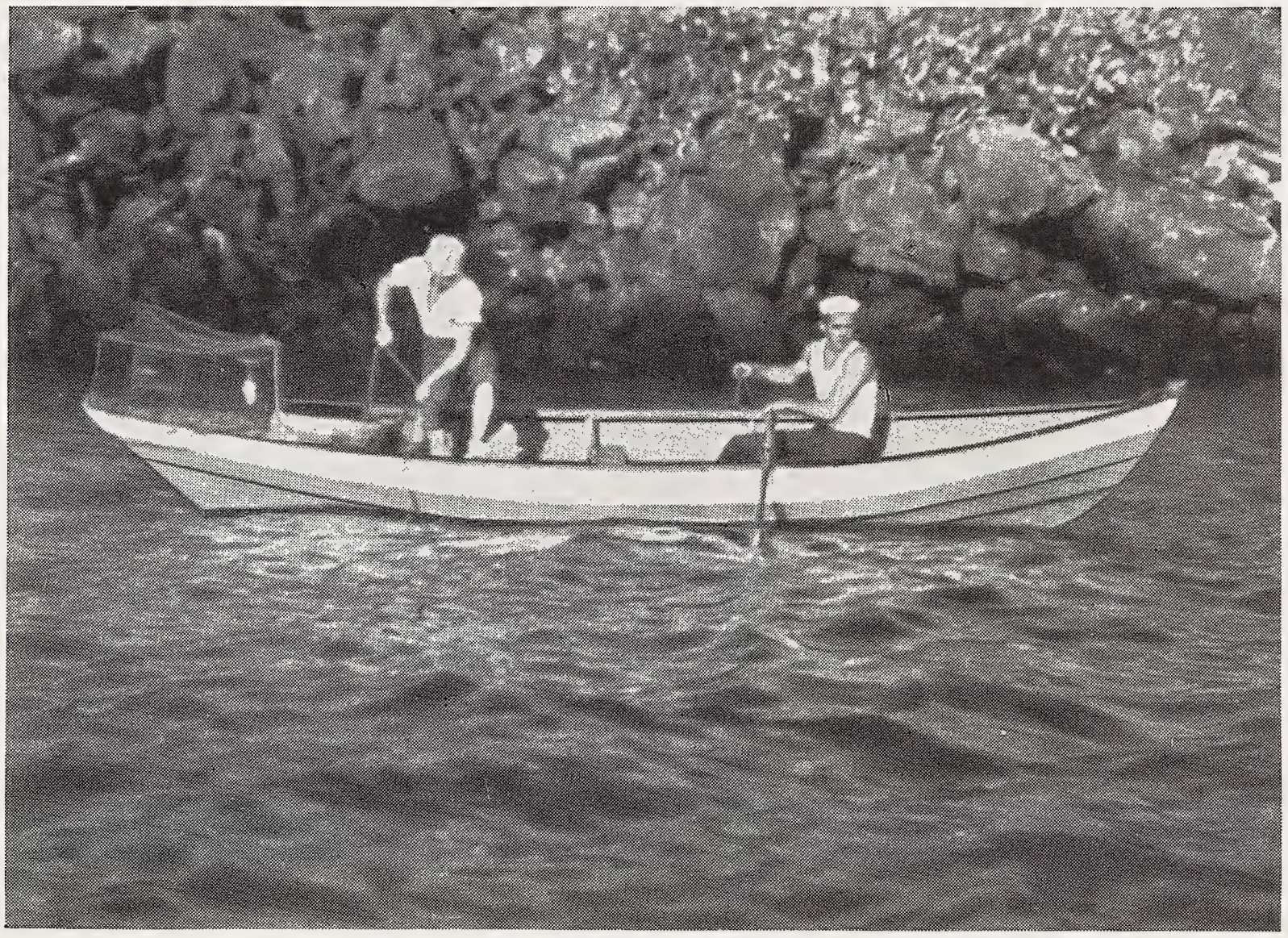
Tahitian spiny lobster. This species differs from the Atlantic *Panulinus* and Pacific *Palinurus* by being predominately a dark green instead of reddish.
From a photograph by P. W. Kearney.



Young sea turtles from the Island of Bora Bora, Society Islands. It is necessary to suspend the food of these small turtles at the surface of the water as the surest means of their getting what they require.

Galapagos Beau Gregory, *Pomacentrus leucorus,* from Tower Island, picking over its eggs which may be seen adherent to the rock in back of it.

The same fish as shown in the preceding illustration fanning its pectoral fin to insure a change of water on its eggs.



Pulling a fish trap, Tagus Cove, Albemarle Island, Galapagos Archipelago. The traps are made of wire and one is shown on the stern of the dory. Most of the specimens brought back by the *Nourmahal* on her first trip to the Islands were procured by this method.

East Indian Reef Fishes: The Aquarium has just received a small collection of remarkable East Indian reef fishes. The most striking among them are the clown fish *Premnas percula,* a peculiarly patterned species crossed by alternate bands of bright yellow and white, the junctures of which are margined with black. Judged by the comments of visitors these bid fair to be the most popular species on display. Their companions, pale green shoal fish, *Chromis,* and black and white *Dascyllus,* distinctly accentuate the gaudy boldness of the tricolored harlequins. These fishes are rarely imported by dealers because of the difficulty of maintenance without flowing sea water.—*C. B.*

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Breeding of the Beau Gregory: The two accompanying illustrations show the care given to the eggs by the Galapagos Beau Gregory (*Pomacentrus leucorus*). These fishes were brought to the Aquarium on the first *Nourmahal* expedition, May 2, 1930, and as they proved to be exceedingly quarrelsome they could only be kept satisfactorily in pairs.

The photographs are of the second spawning, July 3, 1932. The upper one shows the male circulating water over the eggs by a peculiar rocking motion of the body. The eggs are adherent to the rock behind him. The lower shows him picking off the dead eggs. Both spawnings failed to produce young, as after a time the parents devoured them. This is a common happening in aquaria when fishes are disturbed. Since this spawning took place in an exhibition tank, and drew much attention from visitors, we believe this is responsible for the behavior noted. —*C. B.*

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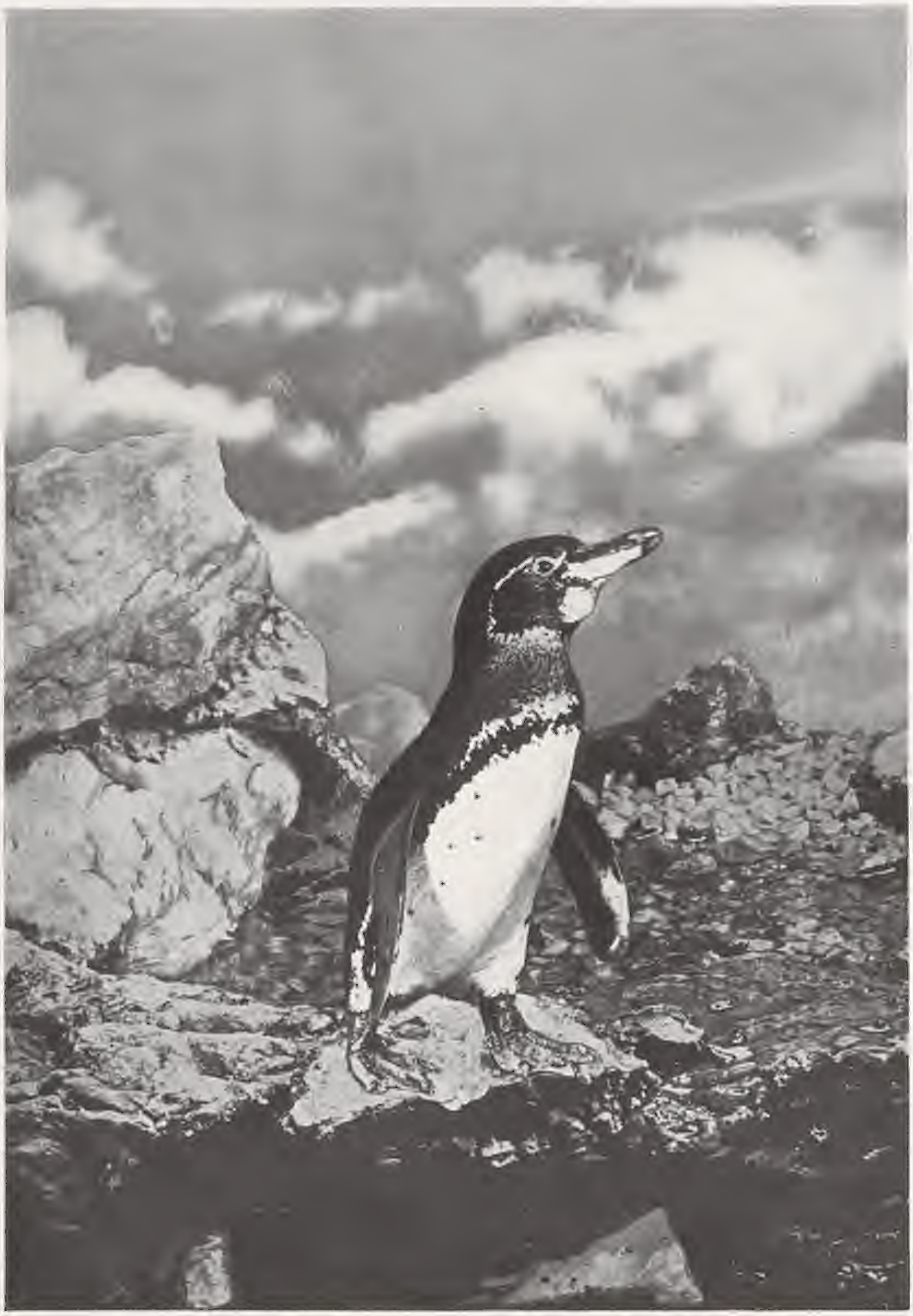
Galapagos Tortoises in Bermuda: Among the tortoises brought from the Galapagos Islands in the spring of 1928 by the writer, were ten young ones varying in weight from three to nine pounds. The total weight of the lot at that time was sixty-six pounds. They were located in Bermuda, forming the twelfth colony of Galapagos tortoises then established in mild climates by the Zoological Society. Later on two locations were abandoned, the tortoises now being in ten colonies. The one in Bermuda has thrived and has had no losses. The total weight of this group on August 10, 1932 was 370 pounds. Their individual weights now vary from thirty to fifty-three pounds. These tortoises



The Galapagos Penguin. The two specimens brought by the *Nourmahal* are of great interest to visitors. This is the only species of penguin found in the tropics. From a photograph by B. R. Sherwood.

have been under the care of Mr. L. L. Mowbray, Curator of the Bermuda Aquarium and formerly of the staff of the New York Aquarium. They occupy a grassy range adjacent to the Bermuda Aquarium and have been fed some vegetables in addition to the food they get by grazing.

We are now adding to this promising colony six baby tortoises that have been kept at the New York Zoological Park. They go to Bermuda on Mr. Astor's yacht *Nourmahal*. Their growth has been negligible owing to necessary housing in winter and the lack of a grassy range in summer. These animals from islands under the equator cannot lie at night on rain-dampened ground in our climate without acquiring pulmonary troubles.

The other colonies in the south have also thrived. The total weight of the young tortoises located in the south, increased from 1800 pounds in 1928 to nearly 6000 pounds in 1931. Later reports are not at hand. Very rapid growth was made in some localities and slower growth in others where conditions proved to be less favorable.

As some of the tortoises in Florida now exceed one hundred pounds in weight, we may reasonably expect that the unknown breeding age is not far off.—*C. H. T.*

The Life History and Control of a Destructive Fish Parasite at the New York Aquarium

R. F. Nigrelli[1]

SINCE 1926, the New York Aquarium has been seriously troubled with a parasite that has been causing severe injuries to and often death of many of the marine fishes. This parasite was described by Dr. G. A. MacCallum (1927) as a new species *Epibdella melleni*. It belongs to that group of animals commonly known as flatworms, a group which includes the cestodes or tapeworms and the trematodes.

Epibdella melleni is a trematode and more specifically a member of the group known as the monogenetic trematodes in contradistinction to another class called the digenetic trematodes or flukes. The latter forms are invariably internal parasites and are often superficially classified according to the organs in which the adults are found. Thus, they may be intestinal, lung, liver, or blood flukes. These forms have a life-cycle in which two or more hosts are involved. The mature stages produce eggs—each of which contains a microscopical ciliated organism. This larva becomes free-swimming, enters the body of some invertebrate animal (often a mollusk), undergoes metamorphosis to form a sporocyst, and by a series of parthenogenetic generations produces tailed forms called cercariae, larvae of an entirely different type. These second larval forms leave the mollusk, or whatever the intermediate host may be, and directly or indirectly reach the original vetebrate host where they become sexually mature.

The monogenetic trematodes, on the other hand, have a relatively simple life-history as compared to the above forms. No intermediate hosts are involved. The eggs develop directly into adult-like organisms on or in a single host. They are, with but few exceptions, external parasites on fishes and other aquatic animals and are found on the gills, eyes, or scattered over the entire body surface, usually between the scales in the case of fishes. A few, however, are internal parasites living in the oral, nasal or cloacal cavities.

Although the life-histories of the monogenetic trematodes are apparently much simpler than those of the digenetic forms, they have been less extensively studied. Of the five hundred or more species described from fresh-water and marine vertebrates, the life-cycles of but three were known prior to the investigation of Jahn and Kuhn on *Epibdella mellini*.[2] These were *Gyrodactylus, Diplozoon paradoxum* and *Polystomum integerrimum*. The first two are parasites on fishes while the third form is found on the gills of tadpoles in the larva stage and in the urinary bladder of frogs in the adult.

[1] This account is illustrative of one of the problems attacked in the Aquarium laboratory. The advantage of cooperating with special students, in this case the parasitologists of N. Y. University, is evident.—*C. M. Breder.*

[2] This is a report of the work done by Dr. T. L. Jahn and Mr. R. L. Kuhn during the summer of 1930, details of which appear in the Biol. Bull. M. B. L. (1930) Vol. LXII.

The Aquarium in winter. A view of Battery Park from the top of the Whitehall Building. From a photograph by the staff of the *N. Y. American* by courtesy of Mr. Arthur Brisbane.

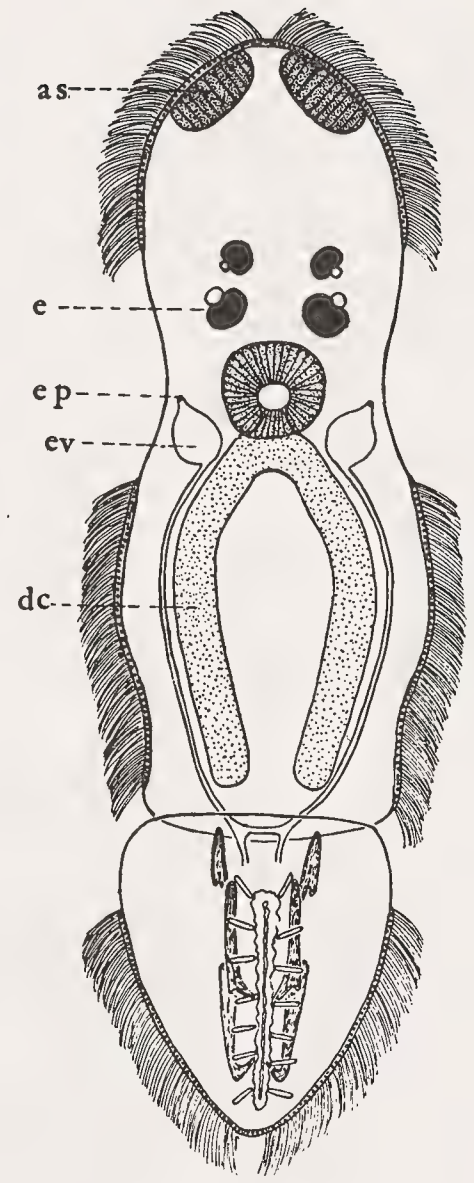
A general view of the recently-opened large aquaria. These two tanks are much larger and deeper than any glass-fronted aquaria hitherto used at this institution. They are back of the floor pool in the foreground.

The mature *Epibdella* vary in size from one to five millimeters in length. They are elliptical in shape with a convex dorsal and a concave ventral surface. The oral sucker lies just behind the two anterior sucking discs and is ventral in position. The genital pore is also on the ventral surface, to the left of the oral sucker. There are two large testes in the middle of the body and a single ovary which lies between but in front of the testes. The intestinal caeca ramify throughout the body and between the rami are found the vitellaria or yolk glands. There is a large round posterior sucker possessing hooks of chitinous material. The excretory system consists of branching channels which unite into longitudinal trunks that pass anteriorly to end in an excretory pore where the waste products of metabolism are emitted. Units of this system are known as "flame cells" the pattern of which is considered a specific character. The excretory pattern was determined and mapped out in detail by Jahn and Kuhn in their study of young stages of *Epibdella.* The nervous system consists of a large crescentic mass in front of the oral sucker. In this mass are embedded four eyes, each of which possesses a black pigment and a crystalline lens. Nerve branches pass from the brain mass to all parts of the body.

Like all monogenetic trematodes this parasite is hermaphroditic but cross-fertilization is necessary. The eggs produced are tetrahedral in shape and bear three filaments—one long and two short lateral ones. The lateral filaments are curved to form hook-like structures. Jahn and Kuhn have found that the eggs hatch in about five to eight days at room temperature. The larva emerges as a ciliated organism, measuring about .225 x .060 millimeters and possesses a posterior sucker that is folded in such a manner as to be non-functional. The animal is, in general structure similar to that of an adult except that the digestive and excretory systems are simple and the reproductive organs are as yet not developed. At this time the organism swims about in the water until it comes in contact with a susceptible fish. If it meets a fish it attaches itself by means of the sucking pads. Within a few hours the larva loses its ciliated covering and the posterior sucker is unfolded and the hooks become oriented in such a manner as to become functional. All these details are shown in the accompanying plate. The parasite then buries its hooks into the softer parts of the host, feeds and grows. During the growth process certain internal changes occur. The sucking pads become definite suckers, the digestive system becomes branched, the posterior sucker becomes larger, and finally, the reproductive system develops. The animal matures and begins to lay eggs.

The life-cycle of *Epibdella melleni* just described differs from that of *Gyrodactylus* in that the latter is vivaparous. In *Gyrodactylus* the remarkable phenomenon is observed that the embryo, while still within the body of the parent worm, develops another embryo in its interior and this again develops a third. It also differs from *Diplozoon paradoxum* in that this parasite, which also has a ciliated larval stage, the young animal does not become sexually mature until two have become permanently united with one another. The direct development of the ciliated larva of *Epibdella* into the adult seems to be more closely related to the type of development described for *Polystomum integerrimum,* except that it is not dimorphic as has been reported for this amphibian parasite. *Epibdella* affects such a variety of fishes that it is much easier to list those that are never parasitized by it. They are as follows: All Elasmobranchs, morays, killifishes, seahorses, black grouper, gag, striped bass, blue fish, blue-striped snapper, gray snapper, grunts, Pacific salema, sheepshead, spot, black drum, Pacific beau gregory, spiny boxfish, shark-sucker, and toadfish.

The injury produced to a susceptible fish is usually quite considerable and if the infection is not treated death often results. The trematodes attach themselves to the epidermis and in most species of fishes they migrate and become concentrated on the eyes. The relative ease with which nourishment can be obtained from the soft tissue of the conjunctiva as compared with the difficulties met with in the coarser substance between the scales seems to be a plausible explanation as to why such a concentration does occur. In such cases, if the infection is not treated, destruction of the eyes invariably follows and the animal eventually dies of starvation. If the infection is very heavy, the epidermis suffers such severe injury that the scales fall off exposing large naked areas of connective and muscular tissues, which usually become sec-



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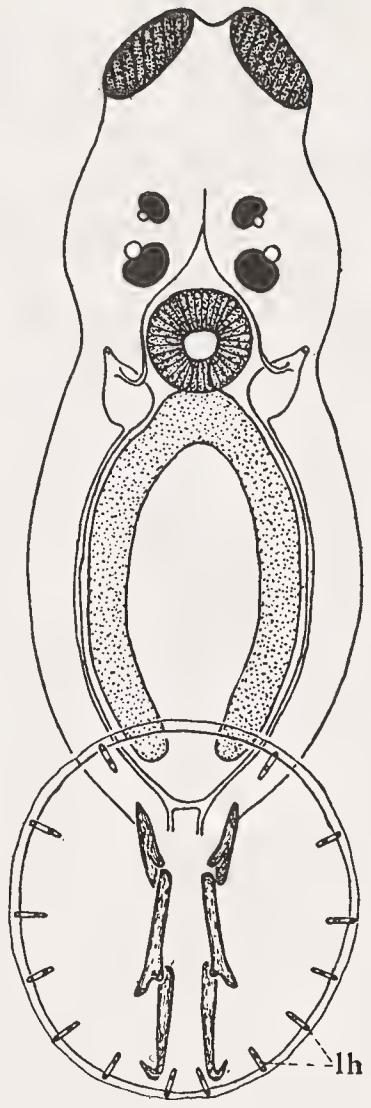

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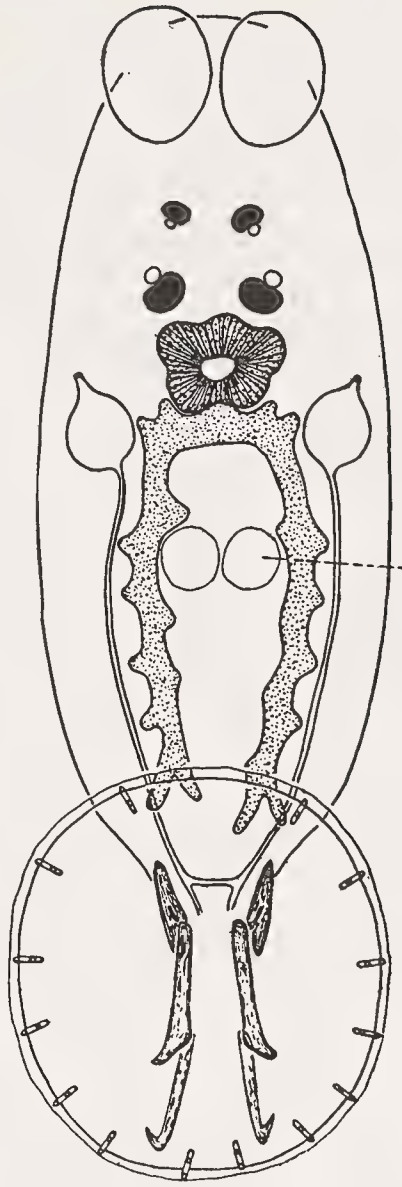

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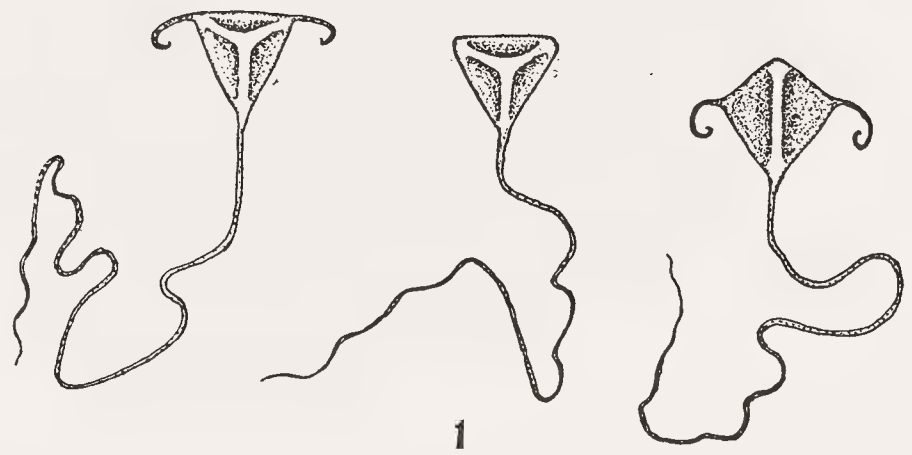

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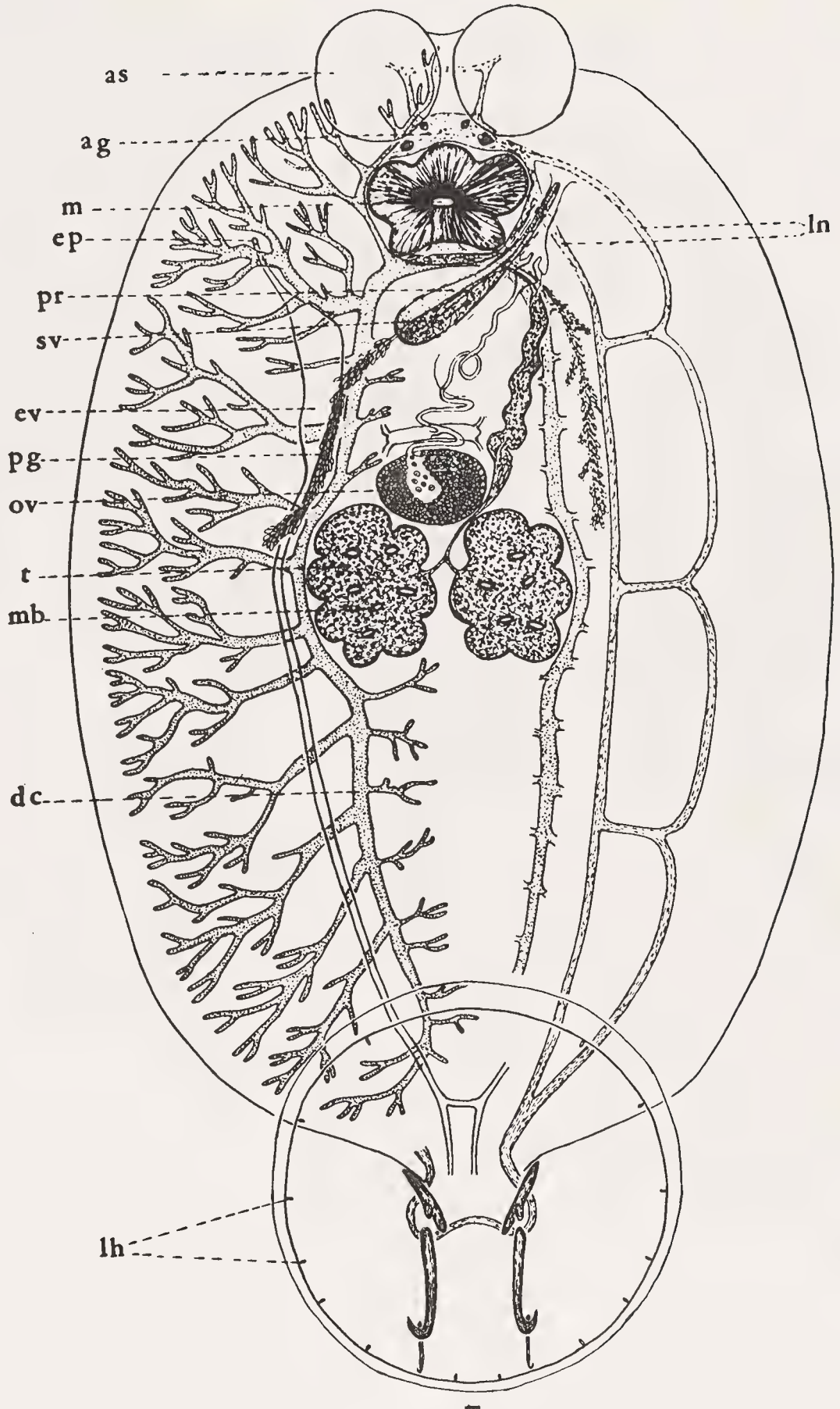

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Stages in the development of the fish parasite *Epibdella melleni*. 1. Most common type of eff *E. melleni*. Length of body of eff about .150 millimeters. 2. Free-swimming larva of *E. melleni* shortly after hatching. Size of specimen about .225 millimeters. 3. Larva which had been isolated when ciliated and maintained under a sealed coverclip for forty-five minutes, during which time the ciliated epithelium was shed and the posterior sucker opened. 4. Young individual obtained from infected fish. Size of specimen about .320 millimeters. 5. Fully matured adult ag. anterior nervous ganglion; as. anterior sucker; dc. digestive caecum; e. eye; ep. excretory pore; ev. genital sinus; lh. larval hooks; ln. longitudinal never trunk; m. mouth; od. oviduct; oes. oesophagus; ol. oral lips; os. oral sucker; ov. ovary; pog. post-oral ganglion; t. testis; yd. yolk duck; yr. yolk reservoir. From Kuhn and Jahn.

ondarily infected with bacteria causing death of the host within a few days.

Although most fishes are susceptible to an infection by *Epibdella melleni,* a few develop some sort of an immunity. Thus, in 1930 a group of black triggerfish became heavily parasitized but after a short time the trematodes dropped off, and since then the fish have been entirely immune against the infection. In another case, the group of Runners was also heavily infected. These were given several treatments with sol-argentum and since then have been free from the parasites even in times when there were great numbers of *Epibdella* in the tanks.

The extent to which fishes of a certain family or even of a single genus seem to be immunized against the parasite also differs quite considerably. This is well demonstrated in the genus *Epinephelus* of the Grouper family. The black-grouper, yellow-fin grouper and the gag show a natural immunity and at no time had any of these fishes become parasitized, although they have been continually exposed to the worms. On the other hand, the Nassau grouper, the red grouper and the red hind are always infected to some degree. The Jewfish or giant grouper, of the closely related genus *Promicrops,* become parasitized only when the trematodes are present in the water system in great numbers and at such times the eyes become the center of the infection.

Unfortunately, the most susceptible ones are among the Aquarium's best exhibition fishes—such as the spadefish, angelfish, hogfish, coneys, graysbys, and yellowtails. These are so readily attacked and are so suitable a host for the propagation of the parasites that they had to be placed in a separate system. That the above fishes are important to the continual existence of the parasites in numbers sufficient to become detrimental can readily be shown. When such are removed to a separate circulation, the percentage of other parasitized species and the numbers of parasites themselves are markedly diminished. This is true to the extent that at the present time they have become almost negligible. Removing these fishes to a separate circulation has bcome one of the most effective means of controlling the parasites. Whether this reduction in numbers can be maintained by continuing the segregation of these fishes from the regular circulation cannot be foretold, because the host-parasite relationships of these trematodes are so variable. That is, since a variety of fishes are susceptible to an attack by *Epibdella,* any one species may become the focus for a future epidemic.

Other means of controlling and eradicating the parasite have been attempted. For a long time the best method of removing the parasites from the infected fishes was by placing them for a few minutes in a one-seventh of one per cent. solution of solargentum in fresh-water. This requires so much tedious labor that other methods have been tried.

The most successful chemical method employed was one worked out by R. L. Kuhn, which consisted of raising the density of sea-water with salt. In the first experiment along this line pure sodium chloride was used. It was found that by adding a sufficient amount of this salt to raise the density to 1.035, the trematodes turned white within fifteen minutes. After an hour the worms lose their hold at the anterior suckers and project from the body of the fish, held there only by the large posterior hooks, apparently unable to disengage themselves.

After three hours the parasites become free from the fish. The fish may be left in such solution for about eight hours without apparent harm. Later it was found that by using rock salt, the reaction was stimulated to a surprising degree, great numbers of the parasites dropping off within a few minutes. Before using this salt it had been supposed that the effect was probably due to the inability of the parasites to adjust themselves to changes in density as rapidly as the fishes. The rock salt apparently contains something which makes the effect more pronounced. One of the advantages of this method is that an entire tank may be treated and then allowed to mix with the general circulation without doing more than raising the salinity a little. With the use of the salinostat, a mechanism worked out at the Aquarium for controlling the chemical equilibrium of salt water, the increased salinity is lowered automatically.

The increased density, applied for a sufficient time to rid the host of the worms, had no effect on the eggs. Experimentally it was found, however, that subjecting the eggs to the increased density for a longer period

Bullheads guarding their nest of eggs in the Aquarium. The entire grayish patch between the two fishes is a mass of some thousands of eggs.

Bullheads rounding up their brood of young in the Aquarium. The dark oval area between the two fishes is composed entirely of coal black young fishes. A few near the lower edge may be seen silhouetted against the lighter rocks.
From photographs by S. C. Dunton.

(twenty-four hours or more) caused a complete cessation of development of the eggs and consequent death of the embryo. Since the eggs hatch four to seven days after laying, repetition of this treatment every four days upon all susceptible fishes would be an effective method in ridding the Aquarium of the parasite. But this method was impractical since it required a very long period of exposure which proved detrimental to the fishes.

Other methods of eradication of the parasites were employed with more or less success. Thus treating the fishes with a three-tenths per cent solution of Eosin, more frequent cleansing of the filters to remove the eggs caught in the meshes, exposing parasitized fishes to ultra-violet rays or placing them for some time in tanks containing bay water were employed. All these methods, however, give only temporary relief since the parasites will reappear just as soon as conditions in the tanks again become normal, for it is almost impossible to rid the circulation of all the eggs. In addition, the parasites are continually being reintroduced into the tanks by new shipments of fishes from Nassau and Key West from where they originally came.

There can be no doubt that the parasites were present in the aquarium prior to their discovery in 1926, but the reason why they have not been observed before lies in the fact that *Epibdella melleni* will not survive very long exposures to acidulated water. Before adequate methods were developed for maintaining the normal alkaline nature of the sea water the parasites did not present a very serious problem. When this detail was worked out it improved the health and longevity of the fishes in a satisfactory manner. However, it happens these conditions are also optimum for the propagation and development of the parasites, which since then have appeared in great numbers.

The Breeding of Bullheads in the Aquarium

C. M. Breder, Jr.

UNUSUAL activity in the gallery tank of bullheads (*Ameiurus nebulosus*) on August 12, 1931 suggested to the attendant that an urge to reproduce their kind was present in some of the individuals. In order to encourage them as much as possible, two days later a few rocks were so arranged as to form a shelter to which they might retire. Almost at once they began to investigate the structure and apparently being satisfied with it cleared away all the gravel under the most sheltered part down to the bare concrete base of the tank.

On the morning of August 18, a large mass of creamy-white eggs were to be seen occupying nearly the entire cleared area. They were about one-eighth of an inch in diameter, adhering to each other and the cement substratum. Both parents were tending them. One, supposedly the male, spending most of time fanning and otherwise causing a current to flow over the eggs; the other, acting for most part as a guard, defending the nest against depradations of other tank mates. These showed such a desire to raid the nest that they were removed, thereby giving the parents every opportunity to attend the eggs. Frequently both parents would work over the eggs at the same time. They are shown thus engaged in the accompanying photograph.

At times parts of the sticky mass of eggs would be taken up in the mouth and churned about, apparently for the purpose of more thorough aeration. This activity tended to reduce adhesiveness and they became scattered about the tank. When it is recalled that the related marine gaff-topsail catfish (*Felichthys felis*) carries its eggs about in its mouth throughout incubation, the behavior of the present species suggests a clue as to how the very specialized habits of the gaff-topsail catfish may have arisen. This constant attention was maintained throughout the period of incubation. The parents would leave the nest for little else than the purpose of feeding.

The eggs hatched on the morning of August 24. The new arrivals were a creamy-white at first but rapidly took on pigment so that when they first began to leave the nest they were coal black. At this time most of the large yolk sac had been absorbed and they were well able to navigate clear of the bottom. The leaving of the nest by the young first took place in a definite way on September 3. Both parents were very attentive to their offspring and herded them about preventing any great dispersion of the closely compacted school. The second photograph shows the parents so engaged. The

Three of the large electric eels at the Aquarium. *(Electrophorus electricus.)*

nearly solid black oval between the two adult fish is a solid "ball" of infant catfish. So black, and light absorbing are they, that the detailed elements of the school are not photographically differentiable. At the edges of the mass, however, a few of the scattered individuals stand out clearly against the lighter rocks.

As time went on the little fish became more and more venturesome and on the average tended to form schools at the surface of the water. In this they were usually thwarted by the parents which persisted in attempting to round them up near the bottom. Finally, however, they became sufficiently agile to elude this herding by the attentive adults and became scattered generally throughout the aquarium. At this time the mature fish seemed to redouble their efforts and thrashed about the tank in a manner that tumbled the young over and over. At this same time these began to die rapidly so that in a few days, by September 15, all were dead. It is not entirely clear as to whether this frantic activity on the part of the parents was responsible or not. In a state of nature, however, the young are usually allowed to form a school at the surface. In local ponds this species breeds at a much earlier date. The reason for delay in this aquarium spawning is not evident. According to various observers, the male alone generally looks after the eggs, as is rather common with a considerable number of unrelated species of fishes. Cases are on record, however, of both sexes showing parental solicitude as in the present one.

Aquarium Notes

Electric Fishes: One of the truly amazing things in nature is the possession by certain fishes of living batteries capable of giving electric shocks. Anatomists say that the living battery shows all the qualities of magnetism and even affects the magnetic needle.

Electric fishes are few in number. The best known are the electric eel of South America, the electric ray of all warm seas and the electric catfish of Africa.

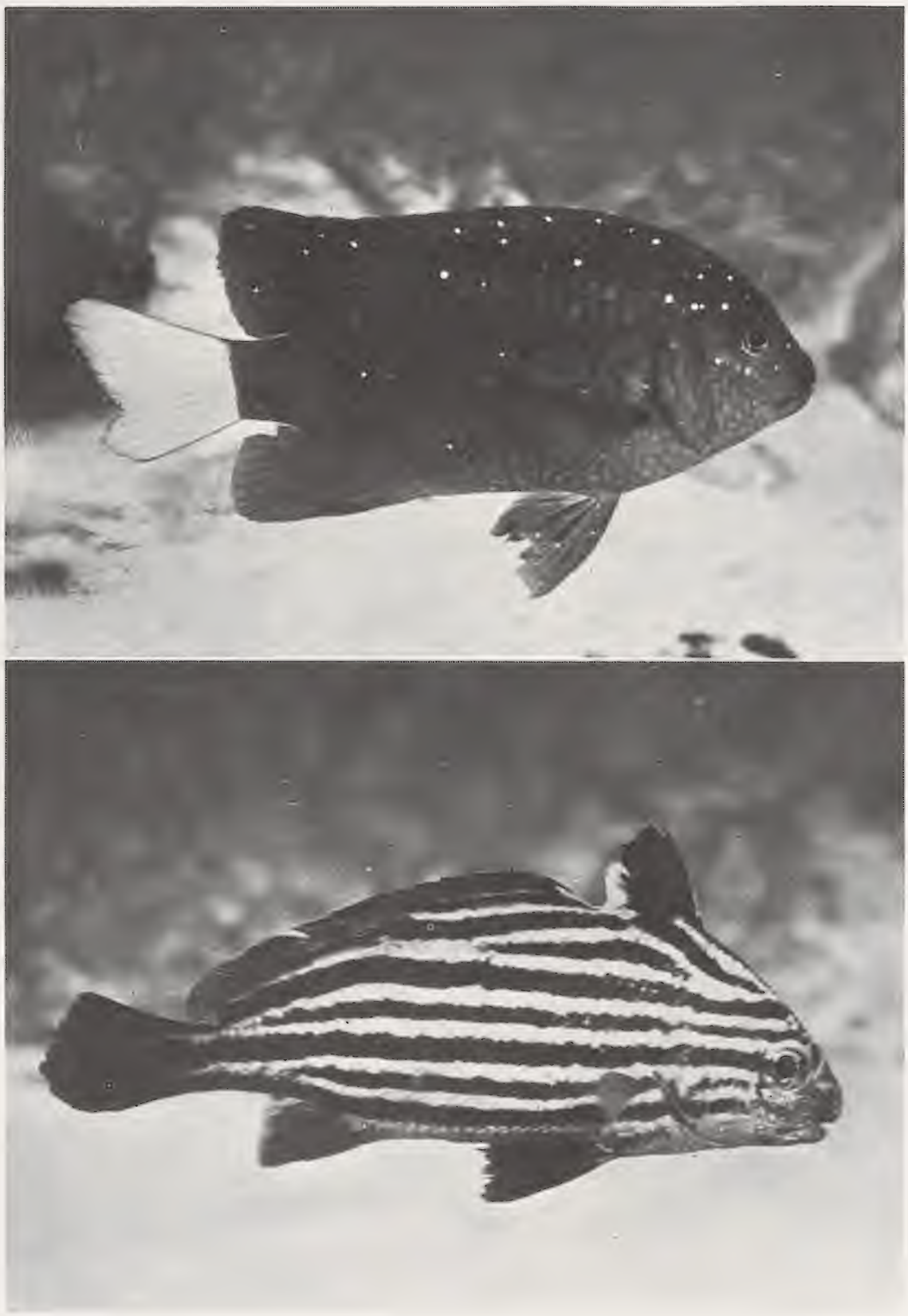
We can dimly comprehend that some ancient fishes had to develop lungs or perish when gills became useless because of lack of water, but the need of electrical equipment is not understandable. Somewhere, however, in the long course of evolution these fishes got it and continue to use it in the capture of prey and for defense from enemies. Man did not master the uses of electricity until some millions of years later.

The electric eels in the Aquarium, some of them nearly six feet long, swim quietly toward the fishes thrown to them for food and stun them by a discharge before seizing them. When the attendants have occasion to move them with nets they wear rubber gloves.

The battery of the electric ray is not so powerful. When at the Naples Aquarium years ago we saw visitors touch some that were kept in shallow water. The shock was light as the attendants had previously reduced the discharge by other means. At the seashore the shock is communicable through a spear. It is even felt through a stream of water poured on the fish when dragged ashore. The power of the fish battery is soon exhausted but is regenerated after rest. The anatomy of this animal battery, different in structure and position in the different species, is well known, but the method of discharge is not understood.

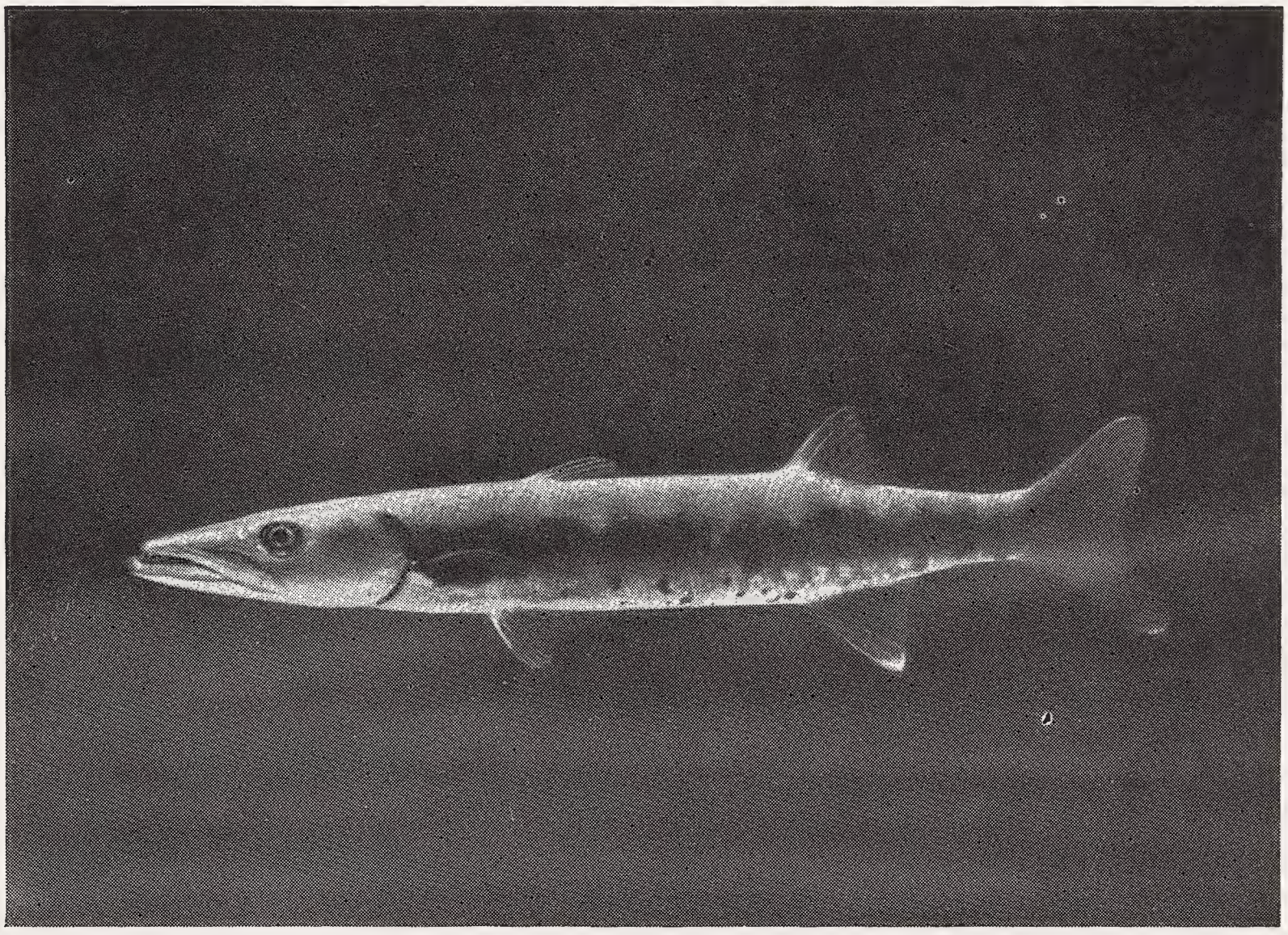
The derogatory expression "the poor fish" is manifestly unfair. In the "battery," developed from his own tissues, the electric fish stands alone. No other member of the animal kingdom invented anything like that.

In make-up the electric eel is mostly tail. We measured one five and a half feet long. Its head is five inches long and its body six. All the rest of the fish is tail, or about five sixths of the total length. There is no dorsal but the anal runs the full length of the tail. Much of the thick and heavy tail is devoted to the large electrical organs. These are in two pairs, one along the back and the other along the anal fin. They consist of an enormous number of minute cells. In the electric eel the nerves leading to these organs are much larger than those passing from the spinal cord for any other purpose. The battery is more powerful than in any other electric fish. The electric eel has whitish eyes of surprisingly small size. In most of the Aquarium specimens



The Golden-tail, *Microspathodon chrysurus*. A small but brilliantly marked reef fish that is unusually difficult to capture.

The Cubbyu, *Eques acuminatus*. A coral reef relative of the weakfish and croaker. Seldom seen in aquaria.



The Barracuda now living at the Aquarium. This fish has retained all the well-known ferocity of its kind, taking its food avidly and attempting, at times, to capture the pointing fingers of visitors on the other side of the aquarium glass.

the throat and belly are colored rather a brilliant red. Its scientific name is *Gymnotus electricus*.—*C. H. T.*

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Floor-pool Dwellers: The seven large floor pools in the Aquarium have until recently been supplied with water pumped from the harbor. The marine animals living in them from time to time, were lung-breathers such as seals, manatees, porpoises and sea turtles. Years ago there was little difficulty in keeping them. One sea lion lived nineteen years. It may have died of old age as a post-mortem examination failed to reveal the cause of death. Sea turtles have also been long-lived. Latterly the lung-breathers have not thrived. Chemical analysis showed this water supply to be unsafe because of increasing pollution. A year ago it became necessary to fill most of these pools with fresh water, when conditions immediately improved. Sea birds such as pelicans and cormorants having done well in fresh water, the Aquarium has now added sea lions and may be able to keep other large lung-breathers. There is little difficulty in keeping sea fishes as the glass-fronted tanks in which they live are supplied with pure stored sea water from a large reservoir. Strangely enough the big sea turtles have apparently not suffered from the gases our chemists found in the harbor water. Most of them have been here more than twenty-five years. These cold-blooded reptiles remain unaffected by conditions the warm-blooded mammals and birds could not endure. Constant chemical control of stored sea water has of late given the New York Aquarium the lead over other aquariums in this country, in the matter of safety for the occupants of the tanks. The enlargement of the tanks has also been a factor in this respect. Losses have been reduced to the minimum. Never in the history of the Aquarium have the living exhibits been as extensive and varied as at the present time. There are on view not less than 400 species and 8000 specimens.—*C. H. T.*

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The Barracuda: A young barracuda is now well established in the Aquarium, the first in many years. This species is rather difficult to transport. Part of the reason for this is its extreme ferocity and the injury that it is consequently apt to suffer at the hands of justifiably cautious fishermen. Many of the attacks on swimmers credited to sharks have been shown to be referable to the barracuda. It is clearly, by far, the

most dangerous species of fish in the West Indies. A length of about six feet is reached, at which size this fish is no mean antagonist. A similar species occurs on the coast of California. The accompanying photograph represents the specimen now living at the Aquarium which gives promise of a long life and has already shown a considerable growth.—*C. B.*

"Kamongo"; the Lung-Fish

(*Protopterus aethiopicus*)

C. H. Townsend

THE Aquarium has some African lung-fishes. The largest are eighteen inches long, but lung-fishes reach a length of over six feet. They were brought from Lake Victoria in Africa by Dr. Homer Smith of the New York University Medical College, who went there especially to get them for scientific experiment.

There are three genera of lung-fishes, *Protopterus* of Africa; *Lepidosiren* of South America and *Ceratodus* of Australia. The Aquarium also has a specimen of *Lepidosiren*.

Lung-fishes wherever they come from are fishes which have almost lost the use of gills, with which other kind of fishes manage to extract from the water the limited amount of oxygen they require. They have developed lungs and must frequently come to the surface for whiffs of genuine atmosphere. The acquisition of lungs by these few kinds of fishes took place millions of years ago. That trick saved them from the wholesale extinction that swept away fishes less adaptive to changes that made a strictly aquatic life impossible. We know them now only as fossils from sedimentary rocks. There are also fossil lung-fishes that did not persist down through the ages.

Existing lung-fishes are among the few survivors of ancient types that found no escape. They burrowed deep in the mud when waters disappeared and managed to get enough air for their salvation until returning waters liberated them. Recurring periods of dryness gradually led to increase of lung power among these adaptive fishes and less use of gills. Wherever lung-fishes are found today they continue to survive dry periods by burying themselves and providing a mud tube to the surface for air. In waters that do not dry up they avoid the necessity of mud life, but their gills are atrophied and they must needs seek air at the surface.

The fish with lungs is one of the "links" with animals of the past that is not "missing." Dr. Smith's book on the lung-fish* is an illuminating account of how this remarkable creature lives in Africa. The first specimens he collected were either *drowned* because they were entangled in nets, or drowned in unsuitable vessels where they could not rise to breathe. After he discovered that they needed more air and less water his troubles were over. Waters happened to be high at Lake Victoria and Dr. Smith did not get half-dormant lung-fishes in their dry mud cocoons which make transport easy, but he brought active ones in shallow water to New York without any losses. In his laboratory some were allowed to form cocoons in American mud. One has been in dry mud for three years and is still sleeping. Its breathing is detected with a microphone.

"Kamongo" is not merely a book for naturalists. It is also a discourse on the meaning of life and the processes of evolution. The book is a readable story throughout, not only of active investigations in Africa, but of a voyage through the heat of the Red Sea that is told with the art of a real story-teller.

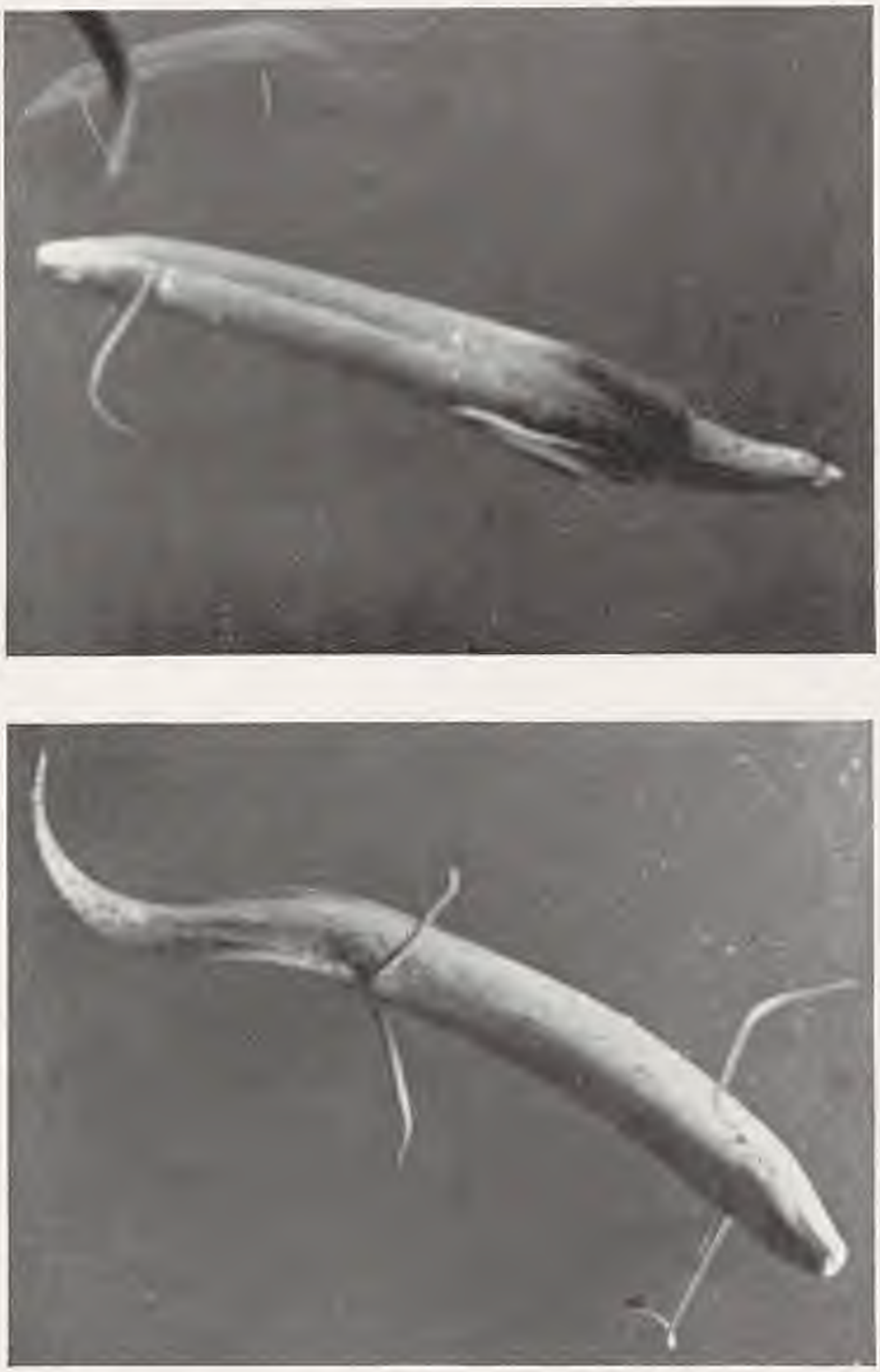
An Early Account of the Killer Whale

MR. MADISON GRANT sends a copy of History of the Wars[1] by Procopius of Caesarea, and calls attention to what may be the earliest description of the ferocity of the Killer (*Orca gladiator*). Procopius was a Byzantine historian, born about the year 490 A.D.

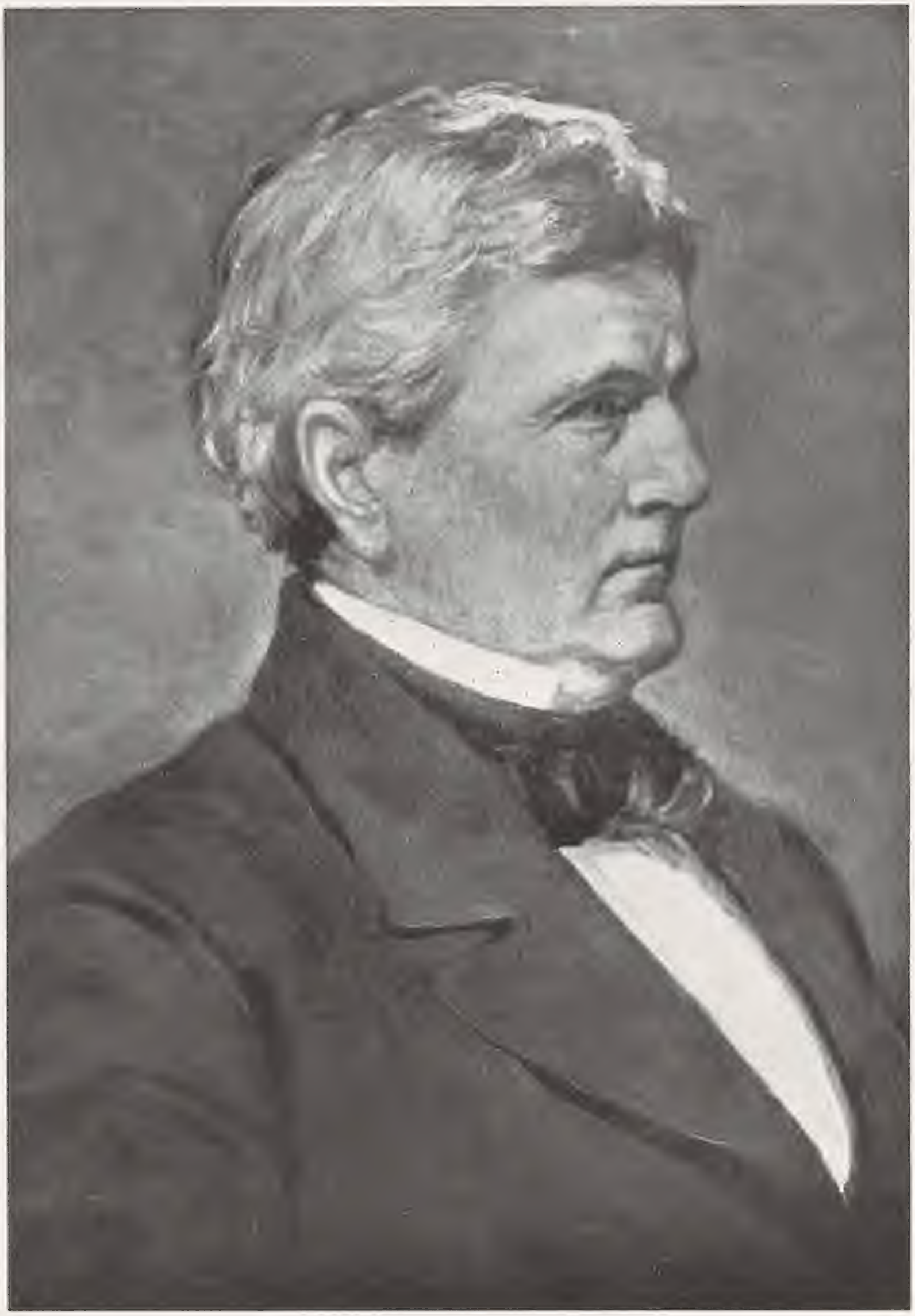
". . . It was at that time also that the whale, which the Byzantines called Porphyrius, was caught. This whale had been annoying Byzantium and the towns about it for fifty years, not continuously, however, but disappearing sometimes for a rather long interval. And it sank many boats and terrified the passengers of many others, driving them from their course and carrying them off to great distances. It had consequently become a matter of concern to the Emperor Justinian to capture this creature, but

* Kamongo. Homer W. Smith
The Viking Press, New York, 1932.

[1] History of the Wars. Book VI. The Gothic Wars. Chapter XXIX.



African Lung-fish, *Protopterus æthiopicus*. A peculiar eel-like remnant of a numerous group known mostly from fossils. This fish breathes atmospheric air and summers in the solidified mud on the recession of the water.



JOHN EDWARDS HOLBROOK
1794-1871
From a portrait in oils made in 1856 by Daniel Huntington (1816-1906). Painting in the collection of the late Thomas B. Clarke, New York.

he was unable by any device to accomplish his purpose. But I shall explain how it came to be captured in the present instance. It happened that while a deep calm prevailed over the sea, a very large number of dolphins gathered close to the mouth of the Euxine Sea. And suddenly they saw the whale and fled wherever each one could, but the most of them came in near the mouth of the Sangarius. Meanwhile the whale succeeded in capturing some of them, which he swallowed forthwith. And then, either still impelled by hunger or by a contentious spirit, it continued the pursuit no less than before, until, without noticing it, it had itself come very close to the land. There it ran upon some very deep mud, and, though it struggled and exerted itself to the utmost to get out of it as quickly as possible, it still was utterly unable to escape from this shoal, but sank still deeper in the mud. Now when this was reported among all the people, who dwelt round about, they straightway rushed upon the whale, and though they hacked at it most persistently with axes on all sides, even so they did not kill it, but they dragged it up with some heavy ropes. And they placed it on wagons and found its length to be about thirty cubits, and its breadth ten. Then after forming several groups and dividing it accordingly, some ate the flesh immediately, while others decided to cure the portion which fell to them. . . ."

There can be no doubt about the species discussed by Procopius. It is the only whale destructive to other whales and hunts in packs like the wolf, killing also porpoises and seals. It is of world wide distribution. The size of the specimen described by Procopius, about forty-five feet by fifteen feet, is exaggerated. Killers, as known to naturalists today, seldom reach a length of thirty feet.

In the January-February number of the BULLETIN for 1930, we published a colored plate of the Killer, from a painting by Charles R. Patterson. An illustrated account of it will be found in the BULLETIN for November, 1925.—*C. H. T.*

A Portrait of Holbrook

Naturalist, 1796-1871

CHARLES HASKINS TOWNSEND

AMERICAN naturalists are indebted to John Edwards Holbrook for the first comprehensive work on the reptiles and batrachians of this country. He published also an important first volume of a work entitled "Southern Ichthyology." The writer is not aware of the existence of any previously published portrait of this naturalist. The photograph from which the accompanying reproduction was made, was presented by the late Thomas B. Clarke of New York, who owned the original. It was painted by Daniel Huntington in 1856. It is evident that in Holbrook the artist found a decidedly manly subject for a very attractive portrait. We have seen the painting. There is no information at hand respecting the personality of the man, but zoologists are well acquainted with his work on reptiles and fishes.

The "American Herpetology, or a Description of Reptiles Inhabiting the United States," was published in Philadelphia in 1842, while Holbrook occupied the chair of anatomy in the Medical College of South Carolina, a position he held for thirty years. This is a notable work in five quarto volumes, with lucid descriptions of species and excellent colored plates. It was highly commended by Agassiz and by European scientists. Holbrook's "Southern Ichthyology, or a Description of the Fishes Inhabiting the waters of South Carolina, Georgia and Florida," was, after the appearance of the first volume in 1847, brought to an end by the outbreak of the Civil War, when the author became head of the South Carolina examining board of surgeons. This work was a volume of 205 pages and 28 plates.

Holbrook was born in Beaufort, South Carolina, in 1794, and died at Norfolk, Massachusetts, in 1871. He graduated from Brown University in 1815, the Medical School of the University of Pennsylvania in 1818, and began the practice of Medicine at Charleston, South Carolina in 1822. Holbrook studied for two years in Europe and published other ichthyological papers in addition to the one listed above. Most of the species of reptiles of the United States that he described as new are still recognized, twenty-two of them being listed by Stejueger and Barbour in their recent catalogue of reptiles and amphibians.

Arctocephalus townsendi, the fur seal of the California Islands.
Modeled by James L. Clark.

New York Zoological Society

The Park and Aquarium

EXCHANGING MARINE FISHES: Mr. Vincent Astor will sail for Bermuda on the *Nourmahal* in September, accompanied by the Director of the Aquarium. The object of the trip is to bring to New York a collection of Bermudian marine life, including both fishes and invertebrates. At the request of Mr. L. L. Mowbray, Curator of the Bermuda Aquarium, a collection of local marine fishes has been taken to Bermuda. Mr. Mowbray is interested in trying to establish certain mainland species in Bermuda waters. The progress of this experiment will be of considerable biological interest, especially concerning problems of acclimatization. To insure the safe transportation of the collections, Mr. Astor has temporarily installed a series of large shipping tanks on the *Nourmahal*.—*C. B.*

DR. TOWNSEND HONORED: At a recent meeting the Board of Managers of the New York Zoological Society presented to Dr. Charles Haskins Townsend a gold medal in commemoration of his thirty years of service as director of the New York Aquarium. At the same time they presented a bronze statuette of *Arctocephalus townsendi* Merriam, the fur seal of Guadalupe Island, discovered by Dr. Townsend in 1892.

There are only two museum specimens of this seal in existence. The statuette was modeled by James L. Clark from the mounted specimen in the American Museum of Natural History. The other seal is in the National Museum of Mexico. The species was long supposed to be extinct. An account of its reappearance was published in Zoologica: New York Zoological Society in 1931.—*E. R. S.*

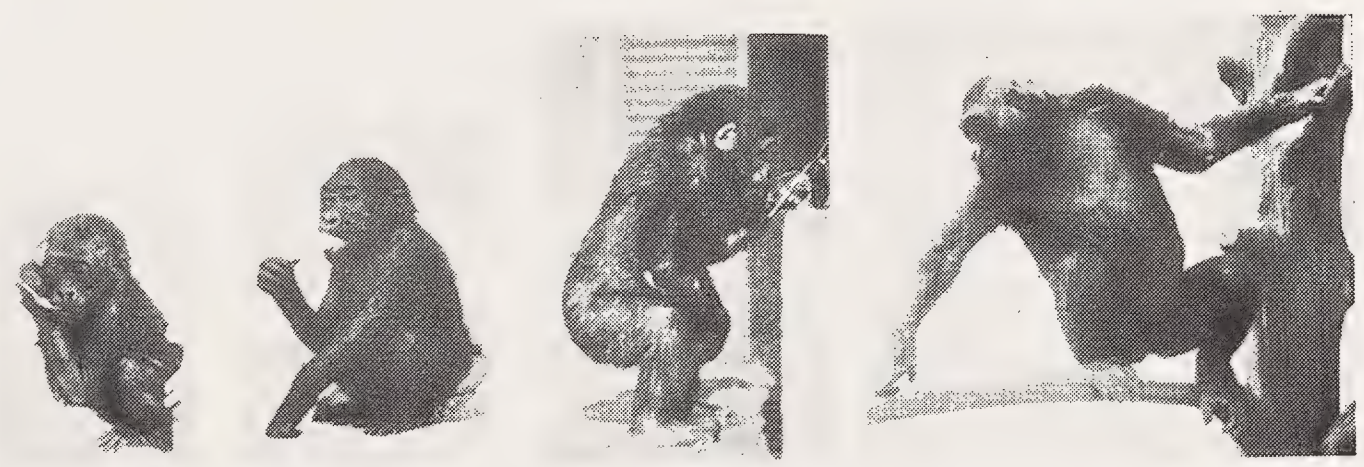
EDUCATIONAL ACTIVITIES: This department has just completed a motion picture entitled "Wild Animals in a City Park," which is now available for school use in New York City. It includes scenes showing various birds and animals that may be observed in most of our larger city parks. Among the birds, robins, barn swallows and song sparrows are shown feeding and taking care of their young. Squirrels, chipmunks and cotton-tail rabbits represent the mammals.

Few persons realize what a variety of animal life persists in a large city wherever it is protected to any extent. All of the scenes were taken within the boundaries of the Zoological Park. The pictures will be available in both 35mm. and 16mm. widths.—*C. W. L.*

"DEEP SEA COLLECTING: For three years now the Bermuda Oceanographic Expeditions of the New York Zoological Society under the leadership of Dr. William Beebe have made collections of deep-sea animals in the same region nine and a quarter miles south south-east of Nonsuch Island, Bermuda. That these collections must be becoming very complete as representative of the deep-sea fauna in that area is shown by a recent publication (*Zoologica*, 13, No. 3), which gives the lists of hauls made during May-November in 1931. Up to the present date, 1350 collections have been made at all depths down to 2000 fathoms in mid-water, the majority being at the surface and between 500 and 1000 fathoms. The fruitfulness of these collections is already shown by two further publications in the same periodical (13, Nos. 4 and 5). In the former Dr. Beebe describes nineteen new species of deep-sea fish, and in the latter the same author and John Tee-Van record six new species of shore fish from that region. It is by such continuous collecting that the sparsely distributed members of the pelagic deep-sea fauna will become better known, and we hope that more material will be accumulated; for until the many unknown forms have been fully classified and described the study of their life histories is impossible."—From "Nature," No. 3271, Vol. 130, p. 63; July 9, 1932.

GORILLA GROWTH-CHART: The growth of the Park's young gorilla from the time of her arrival, October 31, 1928, to the present is graphically shown on the accompanying chart. This chart four by six feet was exhibited by invitation during the Third International Congress on Eugenics at the American Museum of Natural History.

The improvement in the physical condition of the gorilla, Penserosa, may readily be seen by referring to the series of scale-photographs at the top and to the weight curve at the bottom of the chart. Her sitting height during November 1928, was fifteen inches and her weight was

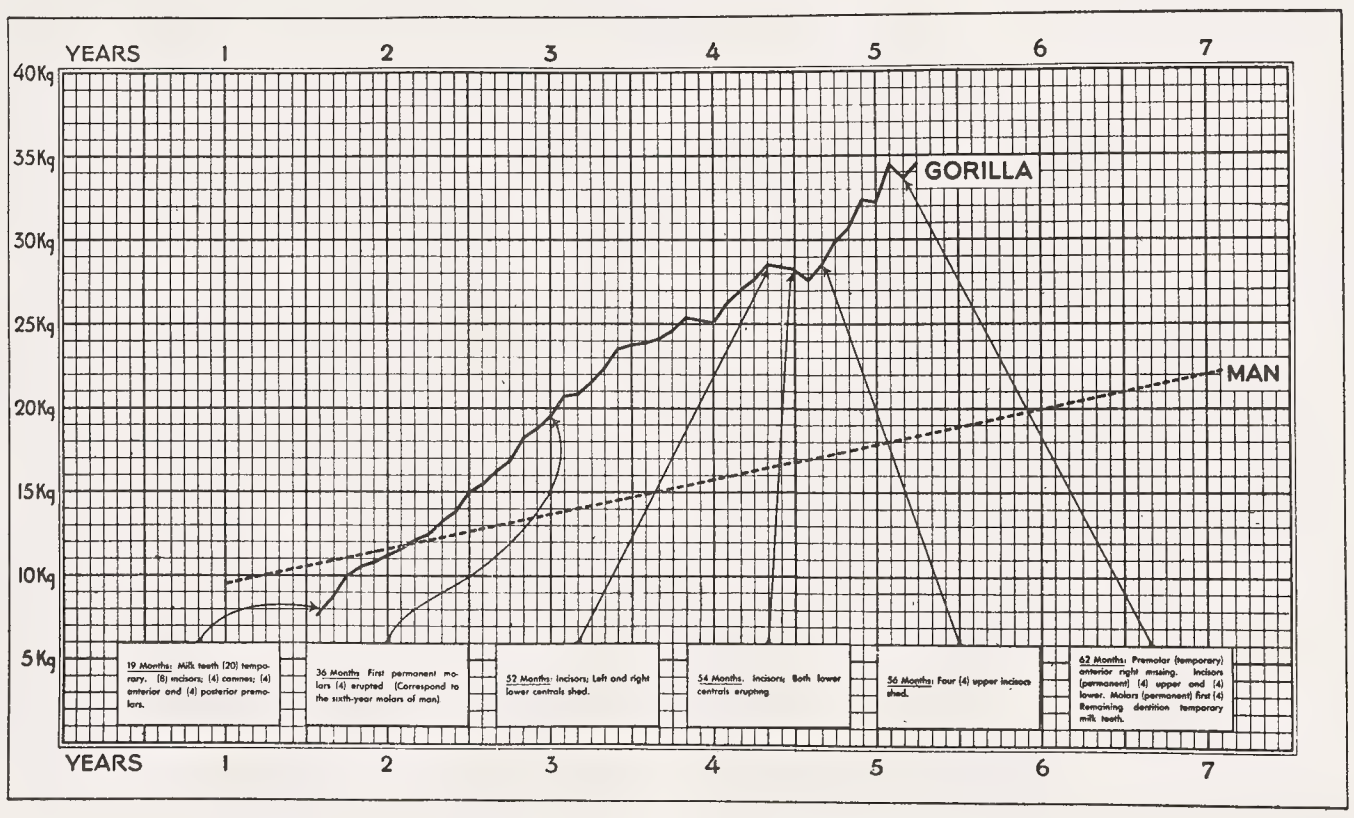


19 months | 20-21 months | 33 months | 52 months

Right Hand--19 months | Left Hand--24 months | Left Hand--36 months | Left Hand--42 months

RADIOGRAPHS OF GORILLA'S HAND. DORSAL ASPECT

1. Ulna. 2. Distal epiphyses of ulna. 3. Lunatum. 4. Pisiform. 5. Triquetrum. 6. Hamatum. 7. Capitatum. 8. Distal epiphyses of 2-3-4-5 metacarpal bones. 9. Proximal epiphyses of first phalanx 1-2-3-4-5. 10. Proximal epiphyses of second phalanx 2-3-4-5. 11. Proximal epiphyses of third phalanx 1-2-3-4-5. 12. Proximal epiphyses of first metacarpal. 13. Multangular major. 14. Multangular minor. 15. Centrale. 16. Navicular. 17 Distal epiphyses of radius. 18. Radius.


YEARS 1 2 3 4 5 6 7
40Kg
35Kg
30Kg
25Kg
20Kg
15Kg
10Kg
5Kg
GORILLA
MAN
19 Months: Milk teeth (20) temporary. (8) incisors; (4) canines; (4) anterior and (4) posterior premolars.
36 Months First permanent molars (4) erupted (Correspond to the sixth-year molars of man)
52 Months: Incisors; Left and right lower centrals shed.
54 Months. Incisors; Both lower centrals erupting
56 Months: Four (4) upper incisors shed.
62 Months: Premolar (temporary) anterior right missing. Incisors (permanent) (4) upper and (4) lower. Molars (permanent) first (4) Remaining dentition temporary milk teeth.
YEARS 1 2 3 4 5 6 7

GROWTH OF A YOUNG FEMALE GORILLA IN THE NEW YORK ZOOLOGICAL PARK

as expressed by

Weight, Dentition and Development of Carpal Bones between 19 to 63 Months of Age

Compiled by Dr. Charles V. Noback

©1932

seventeen and one-quarter pounds. At the present time the sitting height is thirty inches and the weight eighty-two pounds. Her sitting height doubled in four years while her weight increased almost five-fold. The weight is recorded in kilograms (1 kilo. = 2-1/5 pounds).

The rapid development of her wrist bones (carpals), four were present when she arrived and eighteen months later had increased to nine, the appearance of her first permanent molar during the third year of her life, and her marked increase in body weight, indicate a more rapid rate of growth, than that of man over the same period. The first permanent molar in man usually appears during the sixth year and is commonly known as a six-year molar.

—*Charles V. Noback.*

General Information

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee of the Society

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

Publications

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Technical and generally taxonomic description. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Irregular. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Technical and generally taxonomic description. Volume I completed. Volume II in preparation. Irregular. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society; devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-four volumes completed. Volume XXXV in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the collection of Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Publication temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. 21 editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
View of Park: Book; 24 pp. 75 color ills.
Post cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park (*out of print*).
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Pheasants: Their Lives and Homes (Beebe); 2 vols. 4 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

For all publications, other than those referring to the Aquarium or Aquatic Life—address: H. R. MITCHELL, *Manager, 185th St. and Southern Boulevard, New York City.*

Guide Book: Official guide to the Aquarium collections (Townsend). Profusely illustrated, three editions issued. Published as needed.
Sea Shore Life (Mayor); 181 pp. 119 ills. Out of print. To be re-issued.
Cultivations of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Sea (Townsend); 17 pp. 21 ills.
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger); (*out of print*).
Gaff-topsail Catfish (Gudger); 45 pp. 12 ills.
Galapagos Tortoises (Townsend); 82 pp. 45 ills.
Locomotion of Fishes (Breder); 138 pp. 45 ills.
Marine Fishes (Nichols-Breder); 192 pp. 263 ills.
Fishes in the Home (Mellen); 178 pp. 63 ills.
The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs. In boards.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs. In boards.

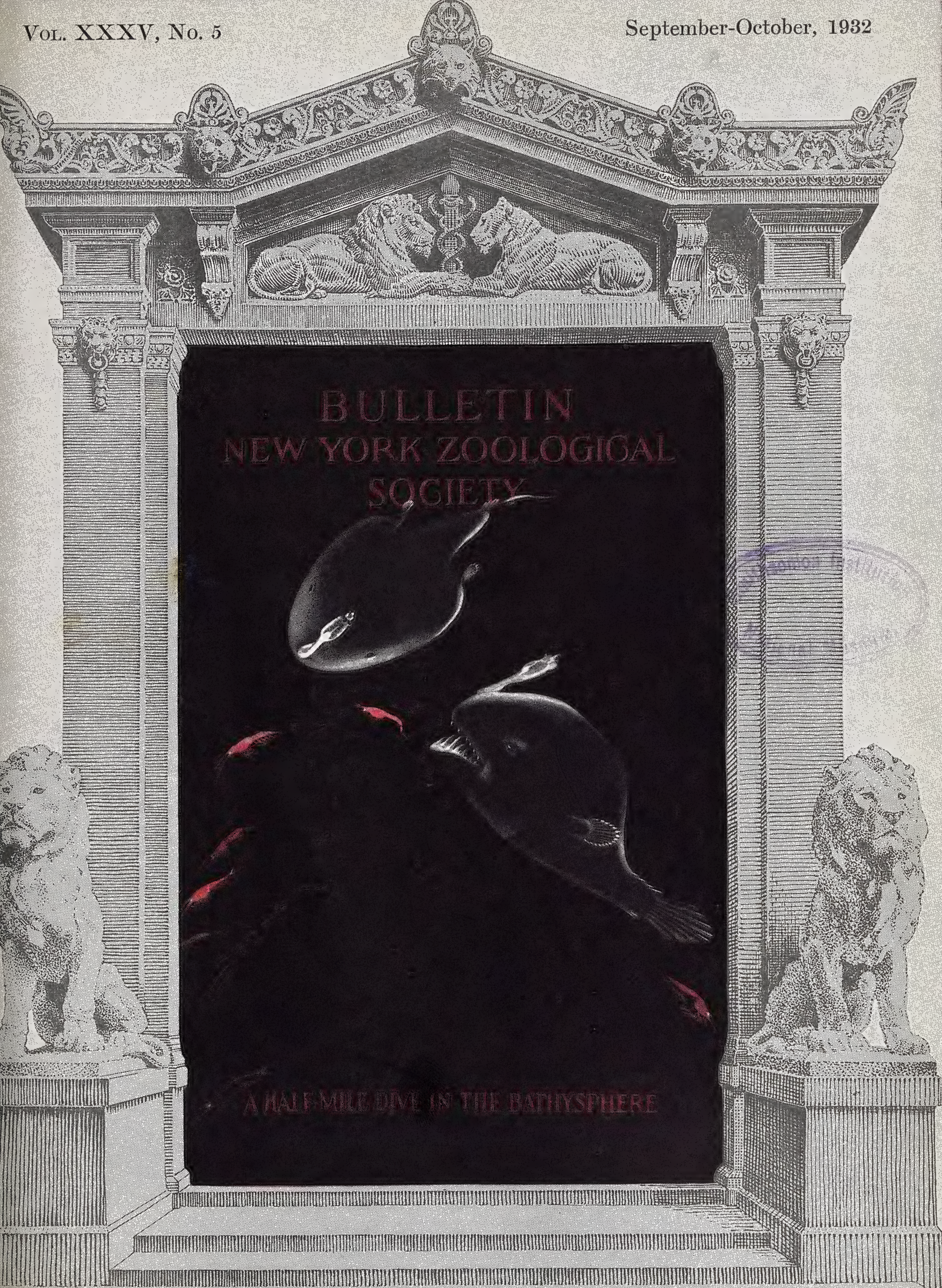
For all Aquarium publications or any work relating to Aquatic Life, address the NEW YORK AQUARIUM, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. MITCHELL, *Manager, Zoological Park, 185th St. and Southern Boulevard, New York City.*

SMITHSONIAN GEOLOGICAL SURVEY

VOL. XXXV, No. 5 September-October, 1932

BULLETIN NEW YORK ZOOLOGICAL SOCIETY



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Vol. XXXV, No. 5

Contents

September—October, 1932

THE ZERO HOUR ..... *Frontispiece*
A HALF-MILE DIVE IN THE BATHYSPHERE ..... *William Beebe* 143
THE DIVE IN PICTURES 146-172
1. Preparation
2. At Sea
3. Test Dive
4. The Half-Mile Dive
THE BATHYSPHERE BROADCAST ..... *Gloria Hollister* 173
A NEW DEEP-SEA FISH
CONTOUR SHORE DIVING
FLYING SQUIDS
..... *William Beebe* 175-177
SILVER HATCHET FISH 144
MID-WATER FISH 179

From Color Plates — Courtesy American Geographic Society

BERMUDA SHOWING NONSUCH ISLAND (Map) 150
POLITICAL BATHYSPHERE 154

From a Cartoon in the Brooklyn Eagle by John Cassel

BLACK DRAGONS ..... *Cover*

Headquarters of the 16th Expedition of The Department of Tropical Research of the New York Zoological Society. A cottage used as a laboratory by Dr. Beebe and his Staff through the courtesy of the Bermuda Biological Station for research of shore waters.

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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Editorial and Subscription Offices, Zoological Park, New York City, Elwin R. Sanborn, Editor.

DEPARTMENT OF TROPICAL RESEARCH

Operations of the Department in 1932

THE Fifteenth Expedition of the Department of Tropical Research was made possible by the courtesy of Colonel Edwin M. Chance, who invited Dr. Beebe and Miss Hollister for a month's cruise among the Leeward Islands in his yacht "Antares." Such little known islands were visited as Union, Tobago Cays, Barbuda and Saba, and considerable collections and notes were made of native fish. Descriptions of new species and other results are now ready for publication. The Sixteenth Expedition of this Department left New York for Bermuda on August 13th and returned on November 23rd. It consisted of the regular members of the staff, William Beebe, John Tee-Van, Otis Barton, Gloria Hollister and Jocelyn Crane. In Bermuda Mrs. Tee-Van joined the party, and Vincent Palmer for two weeks. The Bermuda Biological Station for Research was used as headquarters, a laboratory being installed in a five room cottage (page 141). For this courtesy we are indebted to the President Prof. Edwin G. Conklin and the Director Dr. J. F. G. Wheeler. Seven dives were made in the Bathysphere and considerable work completed on the life histories of Bermuda fish. The Bathysphere was brought back for a thorough overhauling and for exhibition at the American Museum and the Chicago Exposition.

The Zero Hour:—At exactly 1.40 P.M. on September 22nd, with the microphone recording every sound, William Beebe and Otis Barton climbed into the Bathysphere for what proved to be a record dive of 2200 feet. In this photograph McElrath of the broadcasting company is holding the microphone, Tee-Van standing next, Beebe entering the sphere and Hollister holding a box of instruments. Sixteen minutes later the Bathysphere splashed beneath the surface, and two hours and twenty minutes after, it was again safe on deck.

BULLETIN
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A Half-Mile Dive in the Bathysphere

Shown in a Series of Pictures, from Photographs made by the Staff of the Department of Tropical Research.

WILLIAM BEEBE

Director, Department of Tropical Research

IN the Bulletin of the New York Zoological Society for November-December 1930 we described in detail the dives made in that year, and in a future number I shall similarly present all the facts concerning this year's dives. This account is merely a preliminary review of the chief points of interest.

Up to the present time, in company with Mr. Otis Barton, I have made six deep sea descents in the Bathysphere, as follows:

800 feet—	open	ocean,	10	miles	south	of Nonsuch.
800 feet—	"	"	5	"	"	"	"
800 feet—	"	"	6½	"	"	"	"
1426 feet—	"	"	5¾	"	"	"	"
1000 feet—	"	"	3½	"	"	"	"
2200 feet—	"	"	5	"	"	"	"

The first four were made in 1930, and throughout a period of fourteen days. The two last were in 1932, and from first to last required a period of waiting of thirty-eight days.

We had this present year to contend with four threatened hurricanes, one of which came within fifty miles and exposed us to wind velocities of ninety-six miles an hour. We went to sea seven times but except on two occasions were prevented from diving by various reasons: by a dangerous leak in the hull of the tug; by two implosions, around the packing, first of a quartz glass window, and second, of a steel window plate; and finally by such waves and cross swells as would seriously have endangered our lives and apparatus.

On September twenty-second under stress of great haste owing to approaching darkness, and extremely unfavorable conditions of wind and swell, we succeeded in reaching a depth of twenty-two hundred feet.

Sixteen days later, on October eighth, a few hours of quiet weather enabled us to make a second dive for observation and photography to one thousand feet. Immediately afterward I sent Mr. Barton and Miss Hollister down to an equal depth, to enable Barton to complete his photography and to have some of my observations checked up by an independent observer.

During two half-hour periods of the twenty-two hundred foot dive the National Broadcasting Company brought their delicate microphones to bear on the work. From 1:30 to 2:00 P.M. they stood close to the Bathysphere as we were preparing to enter, and from 3:00 to 3:30 they tuned in on the telephone wire over which Miss Hollister and I were talking, and succeeded in getting the vocal interchange from a depth of fifteen hundred to that of twenty-two hundred feet.

The absence of any financial consideration between the National Broadcasting Company and the New York Zoological Society made it possible for me to insist on only indirect communication, by which I mean that we did not say a single word in the presence of the microphones which would not have been said if these instruments had not been present. We have to thank the broadcasting men for aiding in every way in this unusual, and quite atypical, radio method.

The complete absence of first hand observational knowledge of this underworld of the sea

Silver Hatchetfish. Many of these strange fish (*Argyropelecus hemigymnus*) were seen from the windows of the Bathysphere. In the darkness only their lights were visible, but in the electric beam every detail stood out. Their eyes are enormous and look straight upward. From in front they have a singularly human aspect.
Painted by E. Bosteimann.

may be realized from the fact that the lowest depth hitherto reached by a living human being is five hundred and twenty-five feet, attained by a German in a jointed diving dress in a fresh-water lake. Submarines have never reached even this depth, and at best they offer almost no opportunities for observation. I have sat at the periscope of the submarine V-1, as she sank beneath the waves and have watched eagerly out of her tiny ports, but no form of life, nothing but the green water of the upper layers, was visible.

On September twenty-second Mr. Barton and I reached a depth of twenty-two hundred feet. At seventeen hundred feet my spectroscope and photometer showed no glimmering of light, and to the unaided vision the sea outside was wholly black with no hint of blue. So my principal object in making these dives was attained at this depth, that of reaching a point below the level of visible light. From this level down, except during the rare use of the electric light, everything seen was perceived by the light of the animal itself or reflected from other illuminated creatures in the surrounding water. The abundance of organisms, their unexpected activity, combined with the knowledge of the shortness of my period of observation, made concentrated record a very difficult matter.

My classification of lights showed pale blue to be the most abundant, next pale green and only a few times did I see a reddish or a rosy tinge.

The distinctness of the lights was very marked; each one, large or small, whether a sudden flash or a continued illumination, stood out sharply outlined, with no haze or penumbra or halation effect. Twice we saw flashes which can only be described as blinding. For several seconds afterwards I was conscious of the lasting effect on my retina.

The heat of our bodies and the occasional use of the 1000 watt electric lamp kept the internal temperature at about 70 degrees, but outside it was 53 degrees and the walls of the Bathysphere felt cold and clammy to the touch.

The pressure at 2200 feet, or 366 fathoms, could only be grasped intellectually. There was nothing outside or in to make it real to us. On every square inch of my fused quartz window was a weight of 993 pounds or a total of 14 tons on the entire glass through which I looked. The pressure of water on the whole Bathysphere was 5120 tons.

On almost all of my deeper dives one of the most interesting phenomena was the presence of deep sea fish at levels much higher than we ever take them in our nets. In this same area we have pulled 1350 nets from the surface down to 1200 fathoms, so we feel that we know the general distribution fairly well and our Bathysphere observations have correspondingly greater value.

Several concrete identifications will show the value of these observations. Four times I saw large eels, almost always in pairs, very definitely *Serrivomer*. This fish has no light organs, yet each time I could see the outline of the jaws, head and body. This must have been from illumination of very minute creatures in the water stirred up by the passage of the eels, although nothing like separate sparks was detectable. These eels were seen at 260 and 280 fathoms. Our trawling records show that of one hundred and fifty specimens of *Serrivomer,* only ten per-cent have been taken above 300 fathoms, with the maximum at twice that depth.

Of the giant, scarlet crustaceans *Notostomus* and *Gnathophausia,* the maximum occurrence, as shown in our trawling records, is 800 fathoms with only two individuals as high as 600 fathoms, whereas the six which I saw from the Bathysphere were at 260 fathoms.

The explanation must lie in the imperfections of our modern trawling apparatus. The silk nets can be drawn at a speed of only two knots an hour, and in the upper levels there is apparently sufficient diffused light to enable all the larger and more active fish and invertebrates to detect the approach of the net and to avoid it.

The abundance of Pteropods or flying snails is evident on every dive, which is reasonable when we realize that the bottom of this restricted area presents the only pteropod ooze to be found anywhere in the north-eastern Atlantic.

Twice during our deep descent we saw an indefinitely shaped, but very large body of some sea creature pass in the distance through the beam of light. It was pale in color, apparently a grayish white, but whether squid or some giant fish we cannot tell.

The most obvious result of this deep dive was the ease with which accurate identifications could be made. Given a sufficient number of dives and

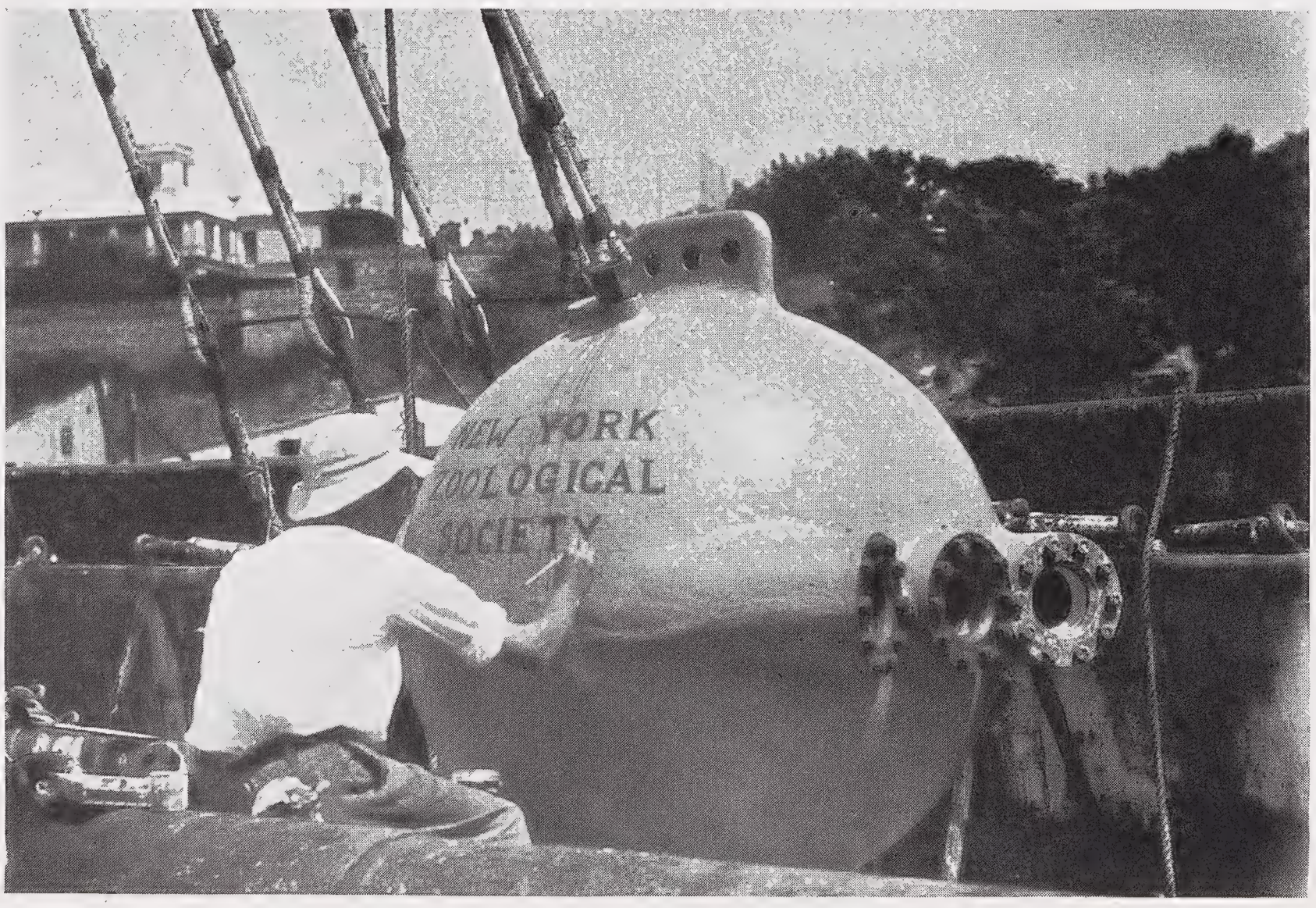
long enough duration of observational periods, and a very accurate picture could be obtained of the abundance, activity, and illumination of a great many known deep sea fish and invertebrates, and recognizable descriptions made of new, unnamed forms. This is amply attested by the many observations on which I am working at present.

I am deeply grateful to the generous contributors to this year's Bermuda Oceanographic Expedition by members of the New York Zoological Society, and to the splendid trio of fellow workers on my staff, John Tee-Van, Gloria Hollister and Jocelyn Crane, each of whom has an indispensable share in every phase of this and all other activities of our expeditions.

A Half-Mile Dive in the Bathysphere

Shown in a Series of Photographs

PREPARATION



The grease-stained sides of the Bathysphere were covered with a thick coat of new paint, and the name of the New York Zoological Society placed on one side. The white lead can be seen around the recently installed, farthest quartz window. It was an excess of this which caused the first leak.

While giving the Bathysphere her first thorough overhauling, she was placed on the deck of a famous old four-masted wreck—the *Taifun*.

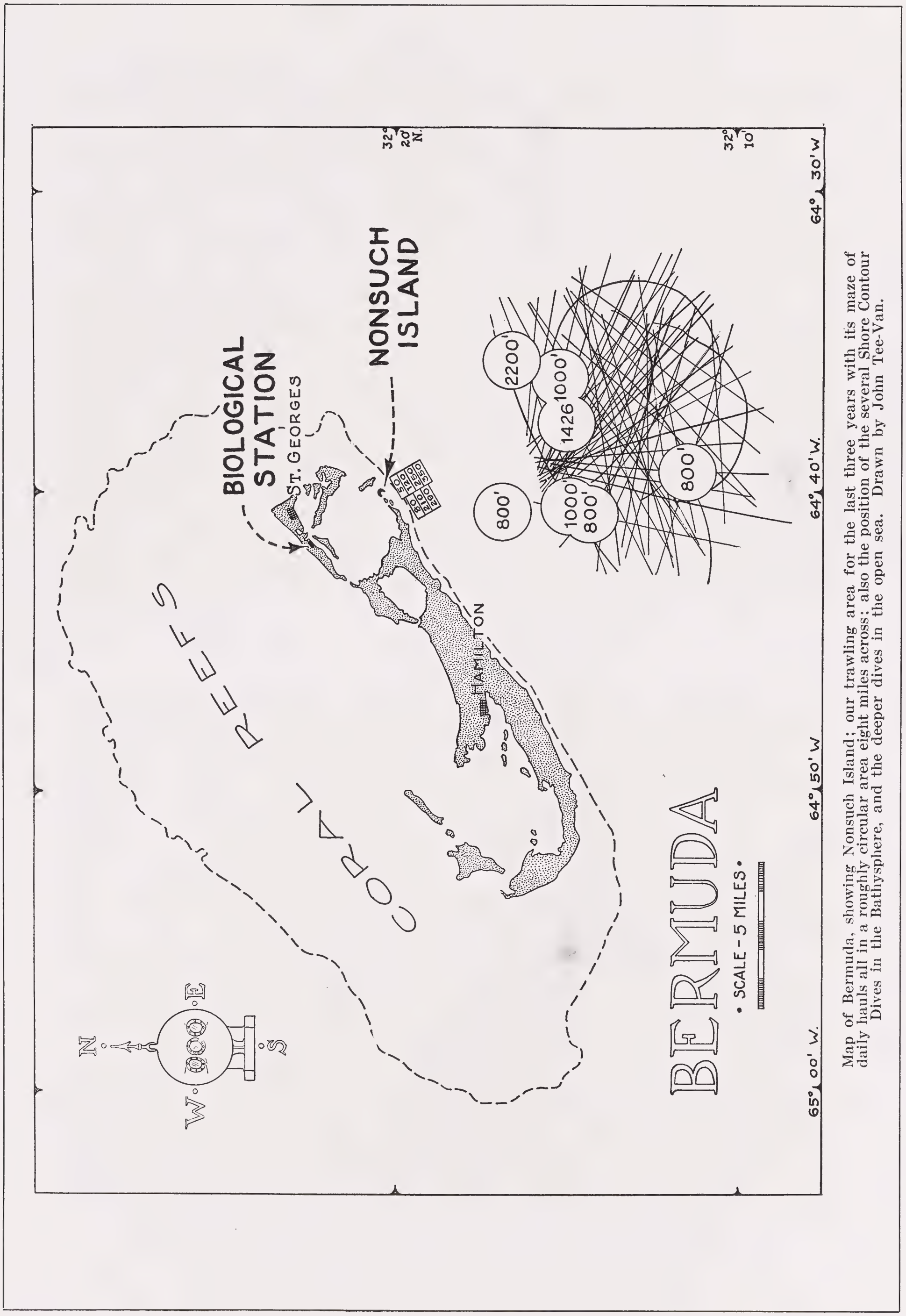
The Bathysphere was painted white in 1930, but this year in order to camouflage it and make it less conspicuous to timid deep sea fish, we gave it a thick coat of dark marine blue, hiding the streaks of grease.

When cleaned of a year's accumulation of rust, and dressed up in its fine new coat of paint, we hoisted the Bathysphere on board the mother ship, the *Freedom,* Beebe and Barton riding on her and guarding the quartz windows from harm.

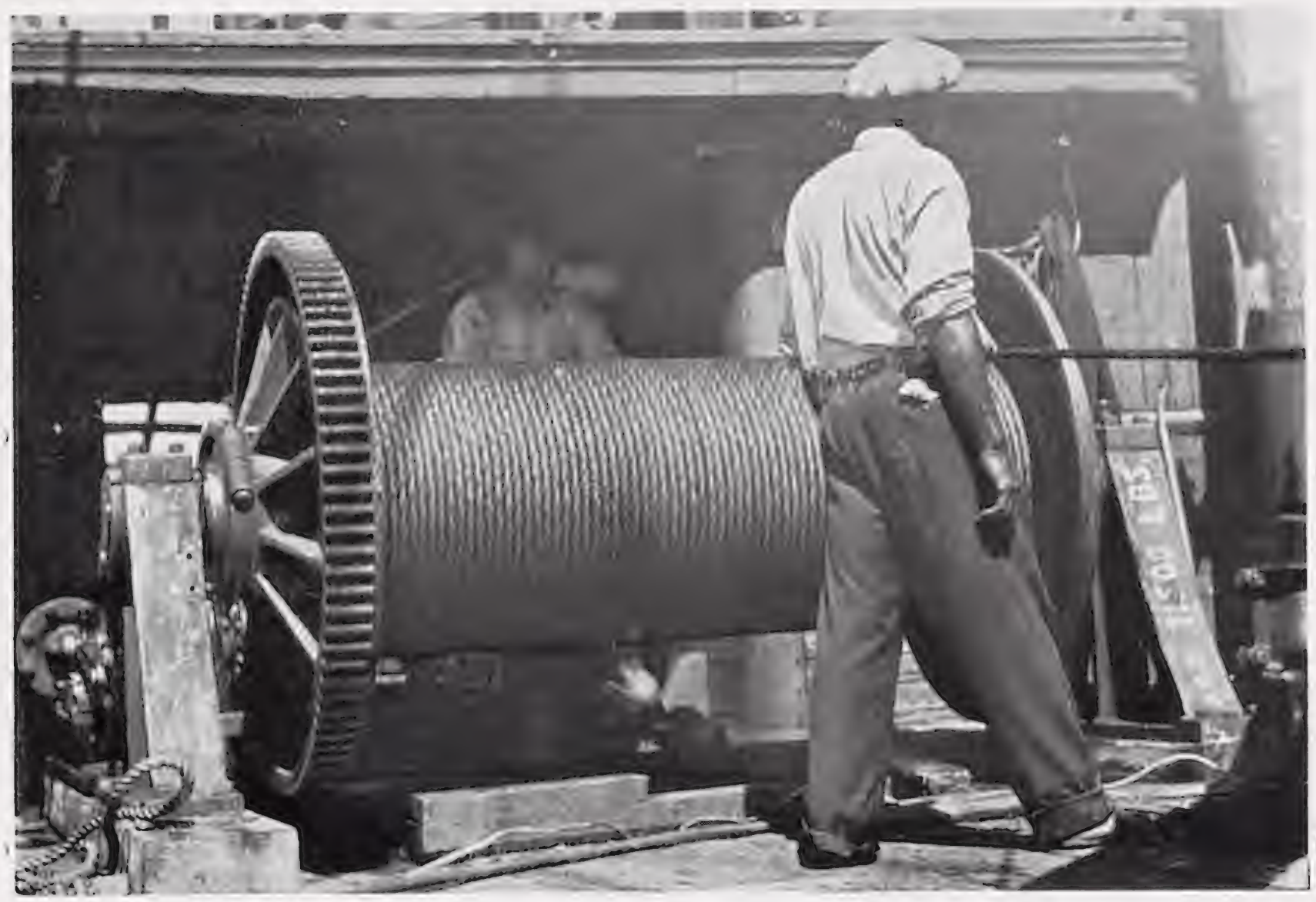
We are now at the wharf where the Bathysphere, the winches and miles of cable have lain in their house for a year and a half. The 3000 feet of rubber hose, enclosing the telephone and electric light wires, are just coming aboard.

We see the Bathysphere on the deck of the *Freedom,* and the enormous yard, brought especially from last year's boat. The low bulwarks and wide expanse of deck make this craft ideal for our work. But she proves to be anything but sea-worthy.

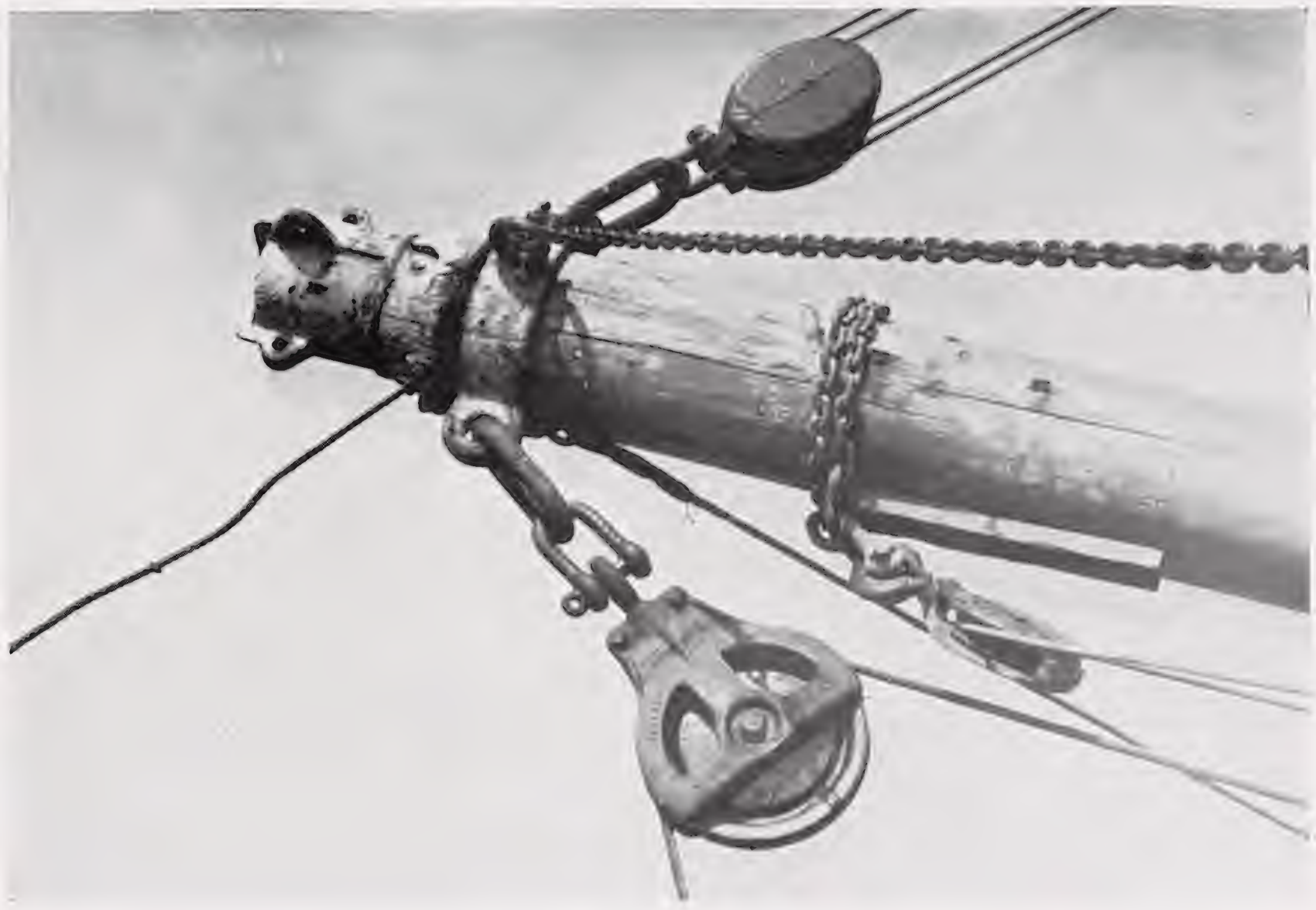
Our first concern is with the steel cable, but when a quarter-mile has been run out we find it as strong and clean of rust as when new. It has a breaking strain of twenty-nine Bathyspheres, so we cease to worry on this score.



Map of Bermuda, showing Nonsuch Island; our trawling area for the last three years with its maze of daily hauls all in a roughly circular area eight miles across; also the position of the several Coral Shore Contour Dives in the Bathysphere, and the deeper dives in the open sea. Drawn by John Tee-Van.



The seven-ton *Arcturus* winch is in place. the cable wound tightly ready for slow or rapid reeling or unreeling. This cable is seven-eights-inch, with a steel core and about one hundred strands, made especially for this purpose by John Roebling.



The giant steel sheeves have been in use for seven years, yet show no signs of wear, and perform their important job smoothly and well.

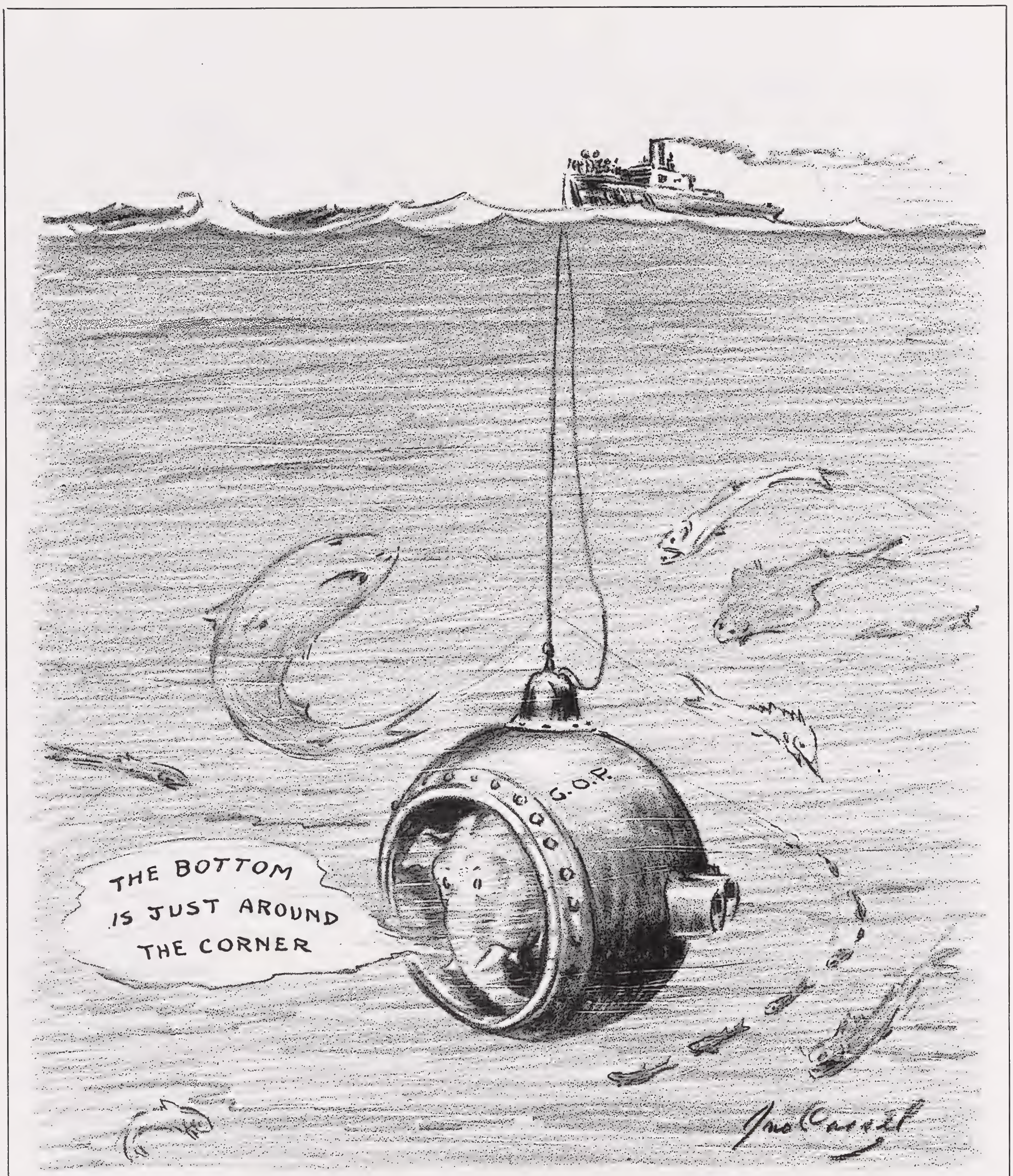
AT SEA

The *Freedom* has performed yeoman service in Bermuda for more than twenty years, and she does all that we ask of her. But with our heavy load, in rough seas, she discovers leaks of which she was wholly ignorant, and the first day we have to steam full speed to shore with the water almost at the level of the engines.

The half-mile of solid rubber hose has now been unwound from its spindle and coiled loosely on deck. One weak spot has been cleverly spliced by a wireless man, and the four internal wires work perfectly, transmitting sound and light. A squall has just threatened, making diving impossible, and the Bathysphere is being lashed to keep it from rolling about.

Before a human being goes down in the Bathysphere it must be sent down for a test dive, deeper than the final descent. The 400-pound door is swung into place and fastened on.

The signal given, the great hollow mass of steel is lifted into the air and overboard. A large tug, the *Powerful,* is seen, standing by in case our boat should again spring a leak.



POLITICAL BATHYSPHERE

The Political Bathysphere. The Zoological Society's Bathysphere has become such a nationally known word that it is used in cartoons such as this. Courtesy of John Cassel and the Brooklyn Daily Eagle.

TEST DIVE

After being lowered to 3000 feet, the Bathysphere is brought up again. One hundred feet from the surface it becomes visible, the ultra-marine appearing pale turquoise. When lifted into the air, the creaking and straining of the machinery shows that something is wrong; the sphere is twice as heavy as it should be.

Straining at its cable, the Bathysphere swings heavily inboard and during a momentary lull between swells, is brought to rest on the landing boards. A glance at the new quartz window shows that a leak has started and that the Bathysphere is filled with water; not from an explosion, but an implosion.

For the first time in our work with the Bathysphere something has gone wrong. The steel sides are cold, and a low hissing sound can be heard. Those in the photograph are Beebe, Tee-Van, Barton, Blagdon and our favorite deck-hand known as OKay.

The central wing bolt is loosened and slowly turned, and almost at once water begins to drip out, the hissing increasing.

Standing far back, with fingers just touching the wing bolt, the Director gives it a last push and, like a shell from a cannon, it flies across the deck and crashes against the steel winch thirty feet away, making dents half an inch deep in the brass. The compressed air and water turn to steam, clouding the entire forward deck.

As the wing bolt turns, more and more water escapes, and the hissing rises to a high scream. On the chance that the pressure might be dangerous, the deck is cleared of people, and the photographer placed far to one side.

When the rush of water, air and steam ceases, the Bathysphere is left half full of water. This feels icy cold to the fingers and a thermometer registers fifty-six degrees, indicating that the break took place at least 2000 feet down.

THE HALF-MILE DIVE

Another test dive is necessary, and this is made on the morning of September 22, a clock being sent down, the ticking audible over the telephone wires until 12:09 P.M. when the clock stopped at 2500 feet. The sphere comes up dry. At the moment of this photograph we are examining every detail of the sphere and watching the weather to decide on the possibility of making the broadcasting and our deepest dive. At 12:55 I decide to risk it.

Here we have five minutes to wait before the zero hour, when the broadcasting begins over the United States and Europe. From left to right Tee-Van, Beebe, McElrath and Barton.

More rapidly than ever before we begin loading the Bathysphere, tightening the stuffing box, attaching the chemical trays, filling them and installing the oxygen tanks.

Perhaps most important is the adjustment of the oxygen valves, which must be perfectly clean and must give out two litres of oxygen every minute—no more, no less.

At 1:30 P.M. the broadcasting begins. This simply means that the microphone is brought close to our group about the Bathysphere, and our general directions and preparations are heard.

A photograph made just as we are about to climb into the Bathysphere, all the apparatus having been installed. The clarity of the fused quartz windows is evident.

Beebe and Barton in Bathysphere for the deep dive. Earphones are on but connection is not yet made. Final examination of the windows.

Both divers inside, giving final instructions and agreeing on emergency signals in case the telephone should cease working.

A thin coating of white lead is placed on the flange of the door to make the junction of steel with steel as perfect as possible.

The 400-pound door is now lifted and swung gently over the ten great bolts, and the mass of steel clangs home.

The mighty brass nuts are screwed into place, each one numbered and fitted to its particular bolt.

The central wing bolt has been screwed tight and now the wrench is pounded with a sledge hammer, so that the wing bolt and all ten nuts seem as if they were a single piece with the whole welded body of the Bathysphere. The noise is terrific on our eardrums as we sit curled up inside.

The door is sealed tight, the signal given, and the two-ton steel ball rises gently, clears the rail and is swung outward.

This is the moment of greatest worry to Tee-Van and Sylvester, who are in charge of the deck machinery. A sudden swell may set the Bathysphere swinging like a pendulum; then a second wave counteracts the movement, and in this propitious second, it must be dropped beneath the surface.

The most delicate part of the operation of the descent is the paying out of the solid rubber hose containing telephone and electric light wires. This must not be bent or rubbed, and every 100 feet is tied to the wire cable with a rope tie.

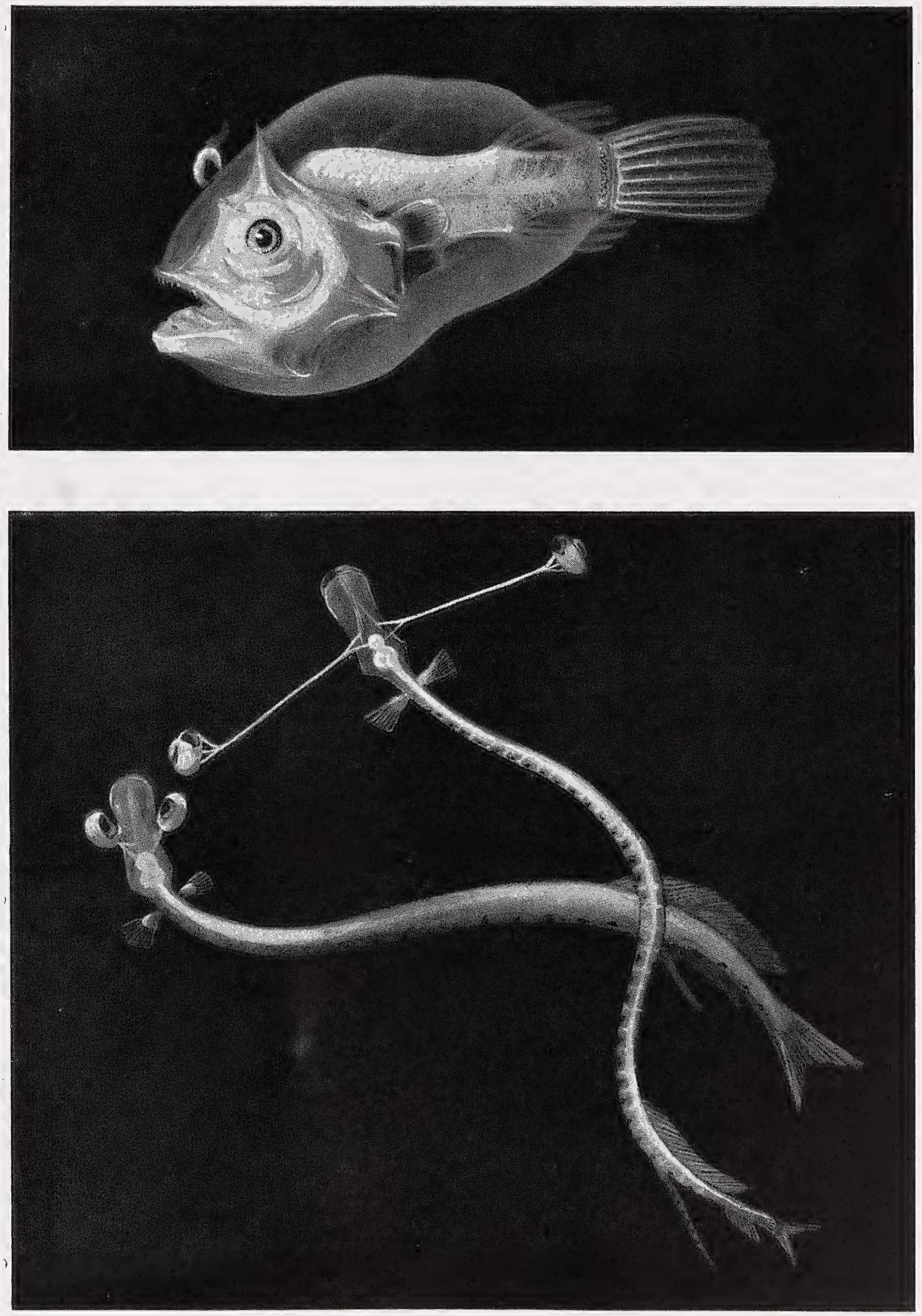
The divers are inside the Bathysphere and the radio men, after waiting for a month through hurricanes and mishaps, are at last in full swing. Ford Bond is announcing, while Resides and McElrath (in charge of the N.B.C. outfit) are watching the mass of delicate and complicated machinery which is sending our voices over half the world.

The dive has begun, and Barton begins his ceaseless watch for trouble at the door, oxygen valve, chemical racks and packing of the hose. Beebe becomes one large eye at the window, trying to see and interpret every possible thing that appears. The ear-phones are in place and hardly a second passes between communications that the phone is not tested for a possible break.

On deck, near the winch, Gloria Hollister is one large ear, recording every exclamation, every fact, answering questions as to depth or speed, passing orders on to Sylvester, the man at the winch, and dictating to Jocelyn Crane the time, depth and position.

At 1000 feet Miss Hollister made this photograph with her camera, showing dimly the strong electric beam shattering the darkness which had been unbroken by human-made illumination for two billion years.

A photograph of the waters of the sea at great depths shows only complete blackness, with a scattering of sparks and lights from the bodies of the fish.



What the camera cannot portray at these depths the human eye can dimly perceive, and remember and fit to the specimens which the trawls of the past three years have brought to the surface and to the artist.

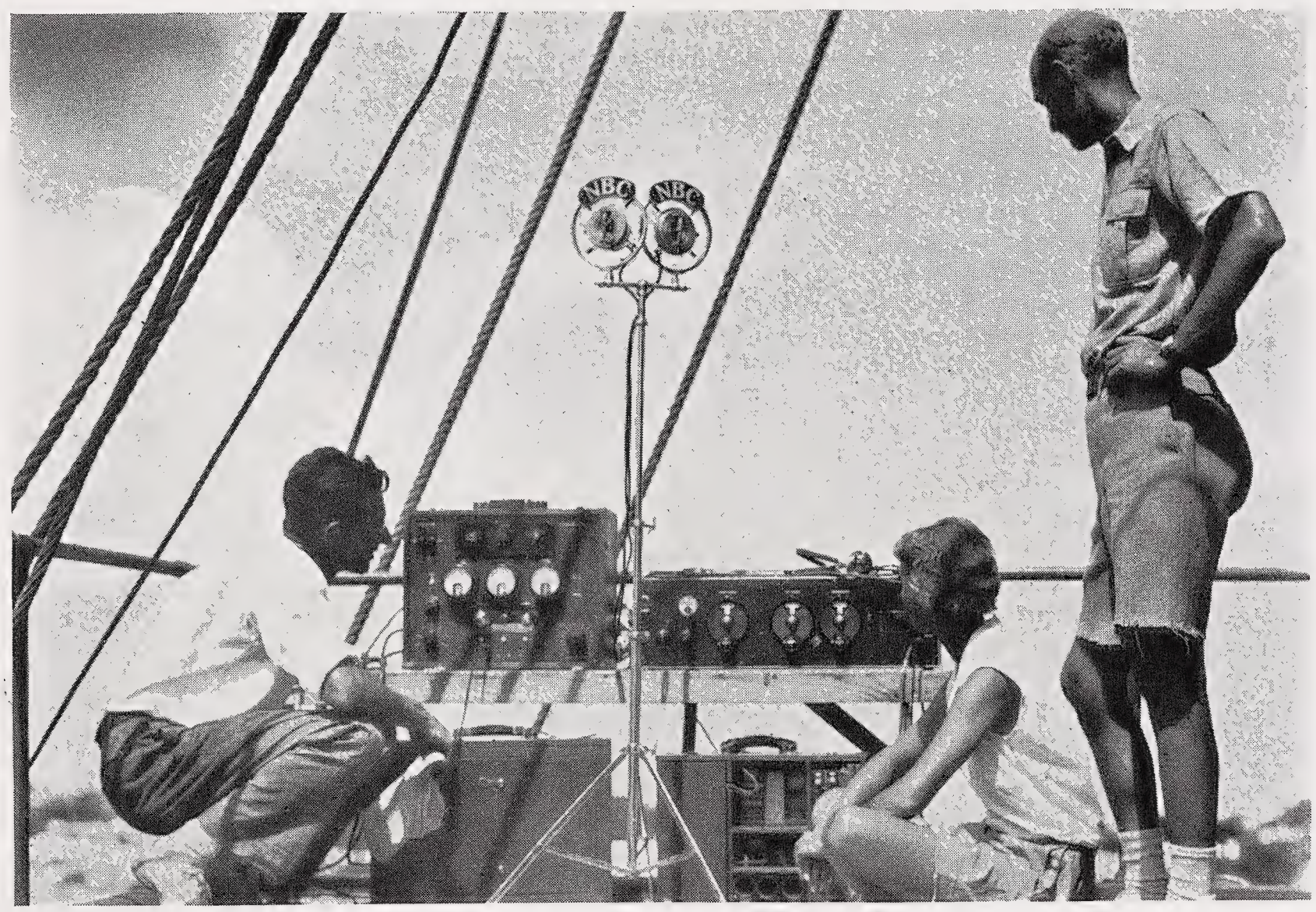
The greatest depth has been reached and now the Bathysphere is on its way up. To save time the rope ties between cable and hose are quickly cut, so there is scarcely a moment's delay at each 100 feet.

Like some great creature of the sea the dark blue sphere breaks the surface, and is held there until there comes a moment of complete steadiness when it is drawn rapidly up, swung inboard and landed.

The wing bolt is unscrewed, very slowly at the last, when the slightly compressed air hisses out. Through the hole, the more delicate instruments are handed out.

The most painful part of the whole dive for the divers is when they emerge, tired and cramped, with feet asleep, and haul themselves out of the fifteen-inch opening of the door.

The glare of the sun is terrific after two hours' confinement in pitch darkness; the air is cool, but hardly fresher than the oxygen-fed atmosphere of the Bathysphere. The horizon seems very far away after the four-and-a-half-foot radius of our recent home. As we look out over the face of the ocean we realize that we know, as no other human beings do, some of the secrets of the creatures which live a half mile beneath our feet.



Station ZFB—1 Freedom. The elaborate wireless machinery was set up on the upper deck of the Freedom, out of the way of harm from people, from unnecessary noises and from flying spray.

The Bathysphere Broadcast

GLORIA HOLLISTER

SEPTEMBER 1932 marks the first time in history that radio engineers have travelled beyond territorial waters of the United States to broadcast a program back to home stations. The Bathysphere of the New York Zoological Society made a record plunge to 2200 feet below the surface of the sea on the twenty-second of September. The dive was made about eight miles southeast of St. Georges from the mother ship *Freedom*. This was the occasion for the field staff of the National Broadcasting Company to set up two complete transmitters and two receiving stations on the upper deck of the *Freedom*. Here was established a special radio station which was called ZFB-1, after the station in St. Georges which is ZFB. Through the courtesy of the Imperial and International Communication Company a license was granted to operate in territorial waters off Bermuda, and its officials cooperated in every way to facilitate the broadcast of this dive. An elaborate technical setup of radio geer was required to transmit to listeners throughout the United States and foreign countries the preparations of the Bathysphere on deck and observations made during the dive to 2200 feet. The engineers considered the problem of transmission from Bermuda to the United States relatively simple. But the installation aboard the *Freedom* of the short wave transmitter to be operated at sea, and the reception facilities on shore, required considerable labor and weeks of preparation. Static, which is often prevalent in the vicinity of Bermuda, had to be combatted.

The broadcast was divided into two thirty minute periods. The first half hour, from 1.30 to 2.00 P. M. described the scene of tense activity on deck preparing and sealing the Bathysphere with its human cargo. Two sound microphones, mounted near the Bathysphere and the big winch, caught the clanging of the sledge hammers tightening the nuts of the door, and the grinding of the winch as it released more and more cable to lower the Bathysphere into the deep. During the second half hour, 3.00 to 3.30 P.M. Dr. Beebe was heard describing what he saw between 1500 and 2200 feet. While at my end of the telephone on deck I recorded his observations and gave him what information he wished as to depths, etc.

Dr. Beebe's voice was carried through 3000 feet of telephone cable from the Bathysphere to the deck of the *Freedom*. On deck the voices

Miss Gloria Hollister immediately after a dive of 1000 feet.

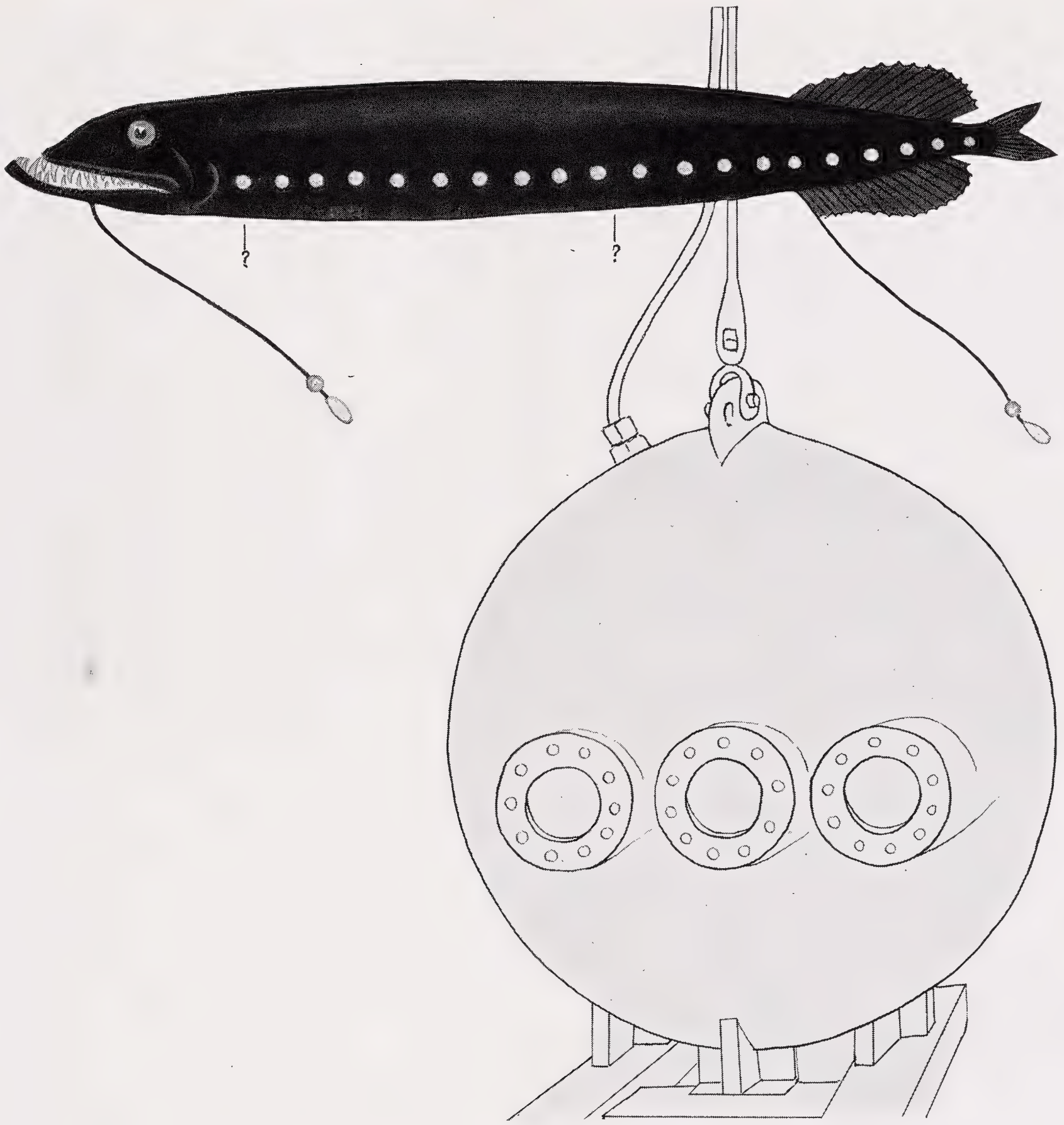
were picked up from the telephone wires and sent over a portable 50 watt radio transmitter (which had a frequency of 2390 kilocycles—125 meters) by short wave to the receiving station at the Flatts. From here it was sent over a special telephone cable circuit to the St. Georges radio transmitter, ZFB (10335 kilocycles, about 30 meters). ZFB's signal was sent over the radio telephone and received at the A. T. & T. Company's receiving station at Netcong, New Jersey and then sent over the telephone circuit to the studio of the National Broadcasting Company at 711 Fifth Avenue. From here it was distributed over the existing networks of telephone circuits of associate long and short wave stations which rebroadcasted the dive on the air for radio listeners from the Atlantic to the Pacific coasts over a combined network of NBC stations, WEAF, and WJZ. It was also sent to England by short wave to be rebroadcasted over networks of the British Broadcasting Corporation.

Cues and instructions from the United States were received over the two radio receiving sets which were tuned to stations WZXL in Boundbrook, New Jersey (NBC), and WNB in Laurenceville, New Jersey (AT&T).

The weather was constantly against us. Rough seas all during September and four threatening hurricanes forced us to abandon the first, then the second scheduled day for the deep dive and broadcast. It is of interest to realize the extent of the Bathysphere Broadcast and the numbers of cities with their outlying districts to which it was distributed throughout the United States. This was accomplished by radio stations in the following cities, in spite of having only two hours notice: New York, Hartford, Boston, Worcester, Providence, Schenectady, Buffalo, Detroit, Cleveland, Montreal, Toronto, Philadelphia, Baltimore, Washington, Richmond, Pittsburgh, Ashville, Columbia, S. C., Jacksonville, Miami, Tampa, Nashville, Birmingham, New Orleans, Shreveport, La., Cincinnati, Chicago, St. Paul, St. Louis, Kansas City, Davenport, Des Moines, Oklahoma City, Tulsa, Denver, Salt Lake City, Butte, Portland, Ore., Seattle, Wash., Spokane, Wash.

During the first half hour of the broadcast fourteen stations in the United States sent out the program. During the second period forty stations sent out the program.

Radio waves travel 7½ times around the world per second. It took 1/20 of a second for the broadcast to travel to New York and back to radio listeners in Bermuda—a distance of 1400 miles.



A New Deep-Sea Fish, by William Beebe. Drawn by Helen Tee-Van.

A New Deep-sea Fish

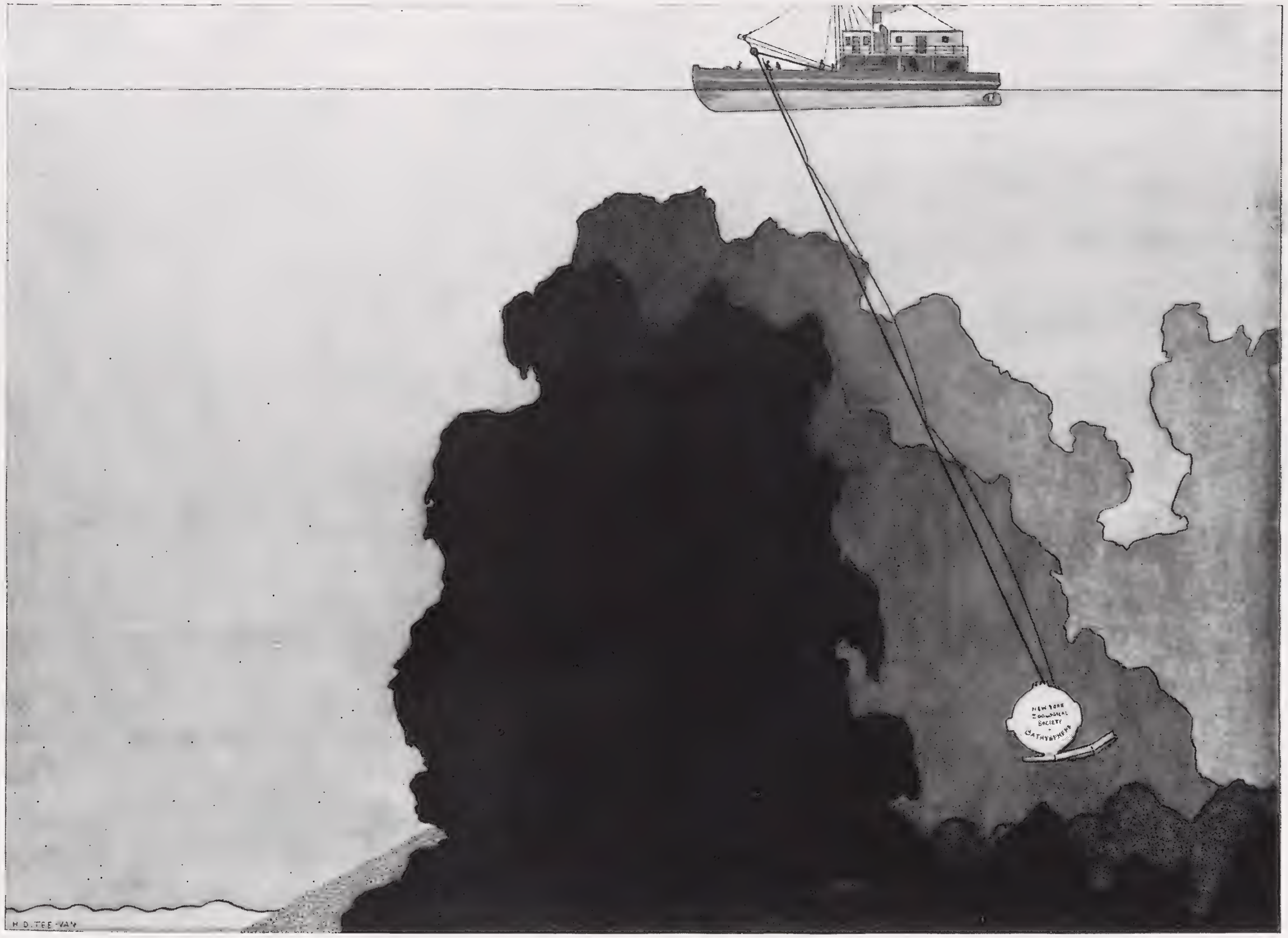
William Beebe

ON the twentieth dive in the Bathysphere, at a depth of 2100 feet, we saw two large, elongate, barracuda-shaped fish, which twice passed within eight feet of the windows, once partly through the beam of our electric light. These were at least six feet in length.

No direct lights were visible on the head, yet the rather large eye and the faint outline were distinct. There was a single row of strong, pale blue lights along the side, large and not far from twenty in number. The mouth, with strongly undershot jaw, and numerous fangs was illumined either by mucous or indirect internal lights along the branchiostegals.

The fish reminded me in general of barracudas, with deeper jaws open all the time. Posteriorly placed vertical fins were seen when they passed through the electric beam. There were two ventral tentacles, each tipped with a pair of separate, luminous bodies, the superior reddish, the lower one blue. These twitched and jerked along beneath the fish, one undoubtedly arising from a mental base, the other so far back that its origin must have been at the anal fin. Neither the stem of the tentacles nor paired fins were distinguishable.

I assume from the position of the vertical fins and the general facies, that the position of the fish must be somewhere near the Melanostomiatidae, but the single line of large, lateral photophores and the two ventral tentacles set it apart from any known species or genus.



The Bathysphere seen just before being rapidly drawn up, barely in time to clear the summit of the submerged range. Beyond is seen the glacial beach. Drawn by Helen Tee-Van.

The depth was 2100 feet, the date September 22nd, 1932, the position 32°17′ No. Lat., 64°36′ West Long., 5 miles southeast of Nonsuch Island, Bermuda.

Relying on this recognizable diagnosis I propose for it the name of *Bathysphaera intacta,* the Untouchable Bathysphere Fish.

Contour Shore Diving

William Beebe

IN addition to the deep vertical dives in the open sea, I had hoped for worth while results from descents near shore. These have been realized in the course of seven dives, ranging from 50 to 350 feet.

The method evolved out of initial experience is as follows: A day of perfect calm with a slight off-shore breeze is a necessity. With the bottom well in sight, at a depth of nine to ten fathoms, the Bathysphere is lowered to within two fathoms of the reefs. An elongate rudder of wood orients the sphere and directs the windows forward, and the shackle, shifted to the posterior hole, tilts the whole apparatus slightly downward in front.

With all these conditions met and my assistant at the other end of the telephone standing close to the winchman, I progress slowly seaward, now and then ordering a fathom or two of elevation to escape a projecting coral crag, or descending as the bottom drops slowly away beneath.

Visibility is usually excellent, except for a few days after a severe storm or hurricane, when cloudiness puts an end to the work. When the water is clear I can make out and identify all coral and algal growths, and fish down to two inches in length. After three years work in diving helmet I am familiar with the fauna down to six and eight fathoms. Below this, a mile or more from land, there is an increase in size of many common fish, such as angelfish, chubs, surgeons, parrots and jacks. Now and then a fish is seen larger than any of its kind ever taken in Bermuda, and this in spite of the fact that angling is carried on down to 90 fathoms.

Certain species of mid-water fish offer unexpected problems. The two most abundant are the Blue Chromis, *Chromis cyaneus,* and the Smooth Sardine, *Sardinella aurita.* The former holds a place on the Bermuda list solely on the basis of a single doubtful record of seventy years ago, while the Sardine is very seldom seen near shore. Yet on these shallow dives I see school after school of each, hundreds of Chromis swimming loosely, and tens of thousands of Sardines in dense formations. When the latter sight the Bathysphere they turn downward, as one fish, and pour past like elongate, silvery rain drops. In the West Indies in July I saw these two species in vast numbers about the shallowest reefs near shore.

Another phase of observation is the physical geography. I have been able to describe and map over a mile of bottom seen from five to twenty feet elevation, traversing it steadily seaward. It is however, all important to keep a constant watch ahead. On my last dive on October 25th there loomed suddenly through the green water a steep, fifty foot crag dead ahead. Fortunately Miss Hollister transmitted my order so instantaneously that we were swiftly raised in time, missing the top by inches.

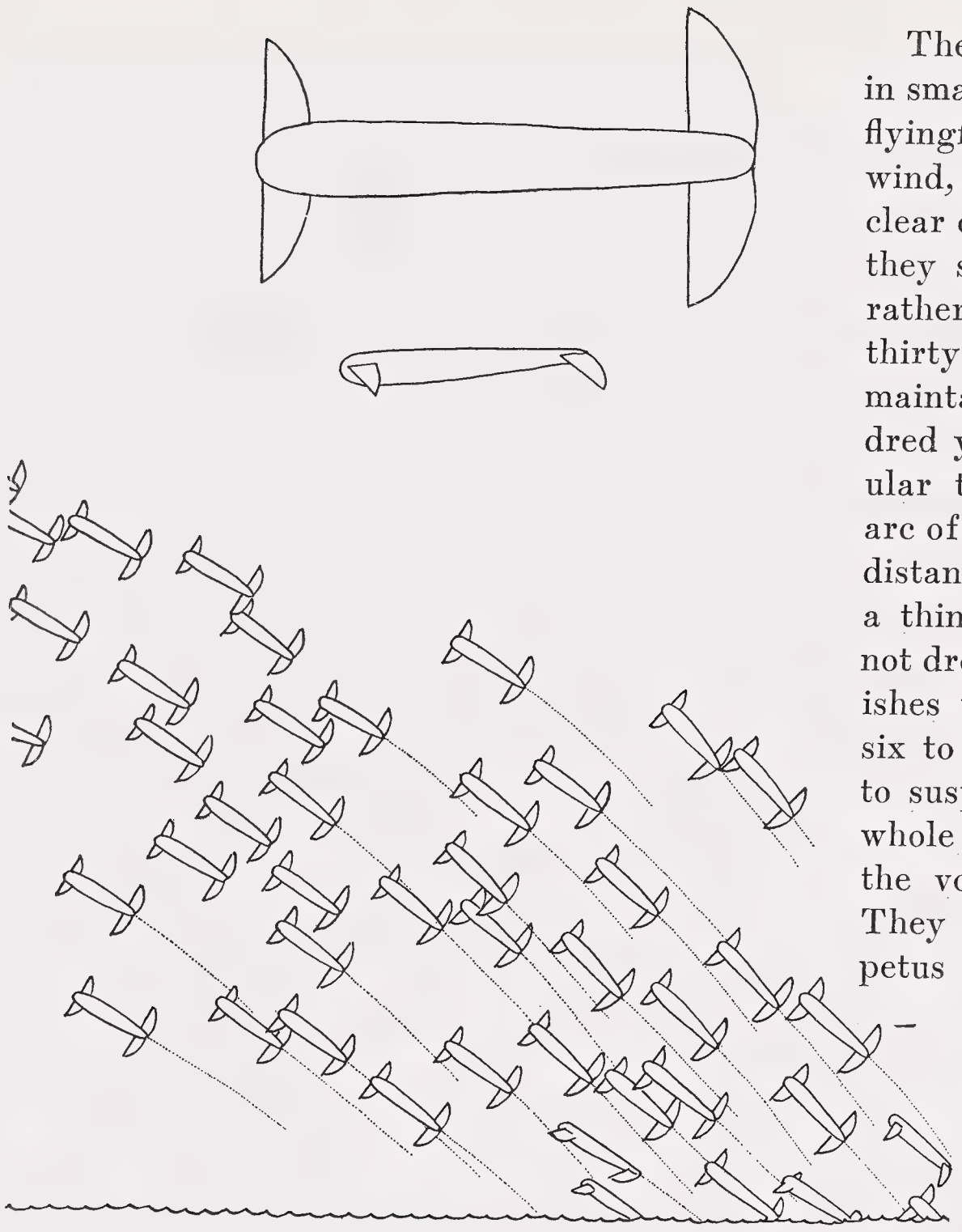
After passing a great loop of the trans-Atlantic cable, all visible life ceased, and we traversed a wide expanse of desert, with no fish or plumes or living coral. Then, after more jagged crags and cliffs, there appeared what must be the sea beach of the last Glacial Age in Bermuda—long beaches of water-worn shells and pebbles sloping down to white sand, marked with deep furrows.

I have never succeeded in following the bottom lower than 350 feet. Increasing cloudiness of the water and greater obscurity have made it impossible to distinguish anything, and the danger of getting hung up and snapped off on some projecting cliff is too constant to progress blindly. At high noon on some calm, brilliant day I hope to be able to continue my seaward travels, and to see for the first time the actual transition between the shore life with which we are familiar, and the organisms of the mid-depth bottom, which at present are as unknown as any inhabitant of Mars.

Flying Squids

William Beebe

ON a trip to British Guiana in 1924 I made my first notes on what seemed to me a wholly new type of flyingfish, which for convenience I called the Biplane Torpedos. Six or eight times since then I have seen them, but not until July of the present year when cruising through the Leeward Islands in the yacht *An-*



Flying Squids. From a pen drawing by Helen D. Tee-Van

teres, did I have the opportunity of watching them at closer range. Again, on August fourteenth, when halfway between New York and Bermuda, Miss Hollister and I saw a school of forty rise close on the starboard bow.

I am now certain that what I have been considering as flyingfish are, in fact, squids, so amazingly like fish that only observation of many hundreds has convinced me. My descriptions have been checked by five people who have seen them with me.

They average six to eight inches in length, are faintly bluish above and silvery below, and shaped like a cigar or torpedo, progressing thick end foremost. There are two pairs of wings, rather small, and so far separated that no hint of a head or tail is visible beyond them. The anterior pair is clear and slightly the smaller, the posterior pair sometimes shows a distinct brown tinge. In some individuals this pair is a full third larger than the forward fins. Miss Hollister is certain that she has detected scallops along the hinder edge.

These mysterious creatures appear suddenly in small schools of twelve to fifty, and, unlike all flyingfish, they invariably rise directly into the wind, never having to change their course when clear of the surface. There is no initial wriggle, they simply appear, rising swiftly and curving rather sharply upward, attaining a height of thirty or forty feet, when they flatten out, and maintain this elevation for as much as one hundred yards. Their formation is much more regular than that of flyingfish, the direction and arc of trajectory being identical in all. For some distance above the surface there trails after each a thin stream of water, almost thread-like, yet not drops, but a solid line, which breaks and vanishes when they have attained an elevation of six to ten feet. It was this which first led me to suspect their cephalopodic identity. On the whole I should consider them as better flyers than the volant fish, in all except actual distance. They never renew their flight or gain new impetus while still in the air, but disappear with little or no splash on a slight downward trajectory.

If, as seems certain, these are flying squid, they progress through the air backward, with the caudal fins spread stiffly, while at the opposite end the arms must be so exactly fitted to one another that they give no evidence of being other than a second, larger, but equally homogeneous fin, wide spread to the wind. This cohesion is perhaps aided by the webbing which probably is stretched between the cerus. The impetus is evidently derived from an expulsion of water through the siphon, as in the usual swift, submarine progression.

Dr. G. C. Robson of the British Museum writes me, "squids do not, as far as we know, fly. They seem merely to shoot out of the water if by chance they are swimming very near the surface in rough weather. Their jumps may be quite extensive but are not really flight." Dr. Paul Bartsch tells me he has seen squid leap fifteen feet out of the water, only to fall back again at once. Admiral Fitzgerald relates that when he was Captain of H.M.S. *Inconstant,* sailing from St. Helena to the Cape Verde Islands, a shoal of flying squid came through the ports twelve feet above the water.

As in the case of the fish, these squids should be credited with a gliding, not a true flight.

Mid-water Fish. Schools of Blue Chromis and Smooth Sardines seen from the Bathysphere a mile off shore. These are almost unknown near shore. From a drawing by Helen Tee-Van.

Painting by E. Bostelmann

While Beebe and Barton were contour diving a mile off shore and forty feet down, a school of many thousands of Giant Blue Parrotfish (*Scarus caeruleus*) swam past the window of the Bathysphere, headed for the deeper, cooler depths of the ocean.

General Information

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Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee of the Society

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For all publications, other than those referring to the Aquarium or Aquatic Life—address: H. R. MITCHELL, *Manager, 185th St. and Southern Boulevard, New York City.*

Guide Book: Official guide to the Aquarium collections (Townsend). Profusely illustrated, three editions issued. Published as needed.
Sea Shore Life (Mayor); 181 pp. 119 ills. Out of print. To be re-issued.
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
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The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs. In boards.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs. In boards.

For all Aquarium publications or any work relating to Aquatic Life, address the NEW YORK AQUARIUM, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. MITCHELL, *Manager, Zoological Park, 185th St. and Southern Boulevard, New York City.*

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Vol. XXXV, No. 6 November-December, 1932

Contents

Pronghorn Antelopes ..... *Frontispiece*
The Pronghorn of North America ..... *Claude W. Leister* 183
Census of the Pronghorn 185
The Deciduous Horns of the Pronghorn ..... *Charles V. Noback* 195
The Dovekie Invasion ..... *Lee S. Crandall* 207
In Quest of the Bushmaster ..... *Raymond L. Ditmars* 213

Illustrations

Head—Mature Pronghorn 185
Pronghorn Antelope (*Plates*) 188-194
Distribution of the Pronghorn (*Map*) 196
Pronghorn Antelope ..... *Cover*

BULLETIN

New York Zoological Society

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Editorial and Subscription Offices, Zoological Park, New York City, Elwin R. Sanborn, Editor.

The first herd of pronghorns on exhibition at the New York Zoological Park. Photograph taken in 1901. The pronghorn is shown here against a leafy background which differs considerably from its native open plains. In recent years encroaching civilization has forced the animal to abandon its former habitat in favor of more difficult wooded country where it is apparently increasing considerably in numbers.

BULLETIN
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The Pronghorn of North America

A brief discussion of its zoological characteristics and the influence of changing environment upon the habits and future of the species.

CLAUDE W. LEISTER

Curator, Educational Activities, Zoological Park.

Illustrations from photographs made in the Zoological Park by Elwin R. Sanborn, except where otherwise noted.

APPROXIMATELY 400 years ago Francisco Vasquez de Coronado set forth from Mexico on his expedition which explored the vast and unknown territories lying to the north as far as the plains of what is now the state of Kansas. The historian of that expedition recorded seeing flocks of goats or deer, spotted with white, and which, upon the approach of the cavalcade, disappeared over the surface of the plains with great rapidity.

That is probably the first account of the pronghorn having been seen by white men. In the years that have passed since that time, the acquisitive and destructive civilization of the white race has almost entirely removed the pronghorn from the picture. Once free to roam some millions of square miles of primitive North America, it now can be found only in scattered localities over that vast area; and its numbers, then counted by the millions, can now be reckoned only in thousands.

Of all the mammals native to North America, only one, the pronghorn, can be regarded as a real native American. All other mammals show fairly close affinities to representative forms from other parts of the world and have reached the North American continent through the migrations of prehistoric ancestors, very little different from their present-day descendents. The pronghorn is no mere importation and it has no living near relatives anywhere on the face of the earth. An animal, almost identical with the present-day form, lived in the early Pleistocene, and it is easy to believe that our pronghorn has come down through the ages and evolved from some deer-like antelope, native to the soil of North America.

The pronghorn, prong-horned antelope or, simply, antelope differs so much from other hoofed mammals that zoologists have given it the distinction of placing it in a family all by itself, the Antilocapridae. No other hollow horned ruminant has horns possessing a branch or prong. Unlike these other ruminants, the pronghorn sheds and renews the sheaths of its horns every year and in addition, the horns are placed directly above the eyes. The animal has become so perfectly adapted to a life on the plains that there are no dew-claws and all traces of the bones of the lateral digits have disappeared.

The pronghorn possesses several other interesting characteristics which are shared by other ruminants. Thus, like the deer, it has a coat of more or less cellular hair with an under woolly coat, and its shedding of the horn sheaths is more or less comparable to part of the process of antler growth and shedding; like the goat, it possesses a system of scent glands; and, in having only two hoofs to each foot, it is like the giraffe. In addition to the above characteristics, it possesses an area on each buttock covered with hairs of varying lengths and which are capable of being erected by a muscular contraction, thus flashing into two conspicuous discs or rosettes of

MAR 15 1933

white. In bright sunlight these serve as especially noticeable flashing devices to convey danger signals to the rest of the herd.

Zoologists are interested in the pronghorn mostly because of its physical characteristics but early hunters and explorers, upon their first acquaintance with the animal, discovered that its psychological make-up was likewise unique and different from that of other forms of game with which they were familiar.

Practically all of the old time hunting accounts mention the intense (and usually distressingly fatal) curiosity of the animal. It was a common thing for the hunter to lure nearby bands into range by lying flat on the ground and waving back and forth a piece of cloth, or any handy article of clothing, tied to the ramrod of his gun. Another expedient was for the hunter to lie on his back and kick his heels in the air. If these efforts were persisted in long enough the animals were practically certain to come in close to investigate. In later years the pronghorn learned to discount such ruses and they became comparatively ineffective, especially where the animals had been hunted a great deal. Dr. E. W. Nelson had considerable success in collecting specimens for the National Museum by approaching his intended victims under cover of a white sheet, they apparently taking him for some harmless white animal. In this way Dr. Nelson collected the type specimens of *Antilocapra americana mexicana.*

The pronghorn possesses an extraordinary racing complex. It has an irresistible desire to race any mounted person or object paralleling its general course, and after passing, to cross over in front to the other side. This cross-over has frequently been made just in front of the horse's nose. Railroad trains and automobiles too, have been raced upon occasion.

As might be expected of a practically defenseless plains animal, the pronghorn has had to develop fleetness of foot in order to escape its enemies. It has accomplished this with a vengeance and it is generally regarded as being the swiftest of our native American mammals. The pronghorn can get under way and out of sight with a speed that is really amazing and early travelers were astounded thereby. Audubon believed that the animal could do a mile a minute. Since his time, and especially since the coming of the automobile, we have been able to measure the rate more exactly. Now we know that it is seldom able to make more than 35 miles per hour. In comparing its speed with that of some commonly known mammals, Seton puts the racehorse first, the pronghorn second and the greyhound third. On the other hand, Seton quotes Governor St. John, of Kansas, as saying that "It takes a mighty good greyhound to catch a mighty poor antelope". At any rate, the top speed of the pronghorn is more than enough to enable it to escape any of its natural enemies under ordinary conditions.

Because of the great speed and agility at its command the pronghorn can make tremendous leaps, either forward or to the side. One has been seen to jump a twenty-seven foot gully, and another, to leap sideways across a pool seventeen feet in diameter. With the gradual settling of the West and the coming of fences, the pronghorn was forced to develop new abilities, since a new dimension, that of height, was encountered. Here the animals were up against an entirely new proposition. Living on the prairie they had never learned to be high jumpers. The first fences proved to be effective barriers to their free migration and roaming over the plain. Encountering a fence, instead of clearing it at a single bound, they piled up along the near side. In 1907 Seton saw twenty-six different bands (a total of 232) against a new wire fence of the Canadian Pacific Railroad.

In time the pronghorn learned to jump fences but even today it prefers to leap through rather than over the ordinary fence. Years ago the animal could easily be confined by a four-foot enclosure. Today a five-foot fence will not always hold him.

The pronghorn diminished greatly in numbers at about the same time as the bison and through very much the same causes. The gradual advance of civilization drove the survivors to the more remote regions of their former range. Even in the earlier days certain bands could be found in the rugged, partly wooded sections, and today, while the open, more fertile plains, offer no haven to them, the animals in the former localities are thriving and in many cases increasing in numbers. It has been said that they have been gradually changing their habits, forsaking their old habitat, the plains, and taking to the wooded areas. Apparently such is the case, and in the

last few years they have shown a marked increase only in these regions.

On reading recent reports concerning the status of the pronghorn in several of our western states it is plainly evident that the change in habitat, as noted above, has been responsible for a large increase in numbers for the states named. This fact, coupled with the much greater interest now taken at large for the animal's welfare, augurs well for the future.

Today, the various states to which the pronghorn is native are striving to do everything in their power that will tend to keep this interesting animal with us for many years to come. Conservation measures have achieved marked success and in several areas it has been found necessary to dispose of surplus animals. This leads us to believe that the future of the animal will be assured through a sane policy of game management and conservation.

A few years ago it was extremely difficult to obtain anything like a fairly accurate census of the pronghorns still remaining in the country. In 1908 the Biological Survey estimated the number to be less than 20,000 for the United States and Canada. About this time they had probably reached the lowest stage in numbers although the census made by the American Bison Society in 1921 records but 11,279 for the same area. However, at this latter time it was particularly difficult to get full information. In 1922-24 Dr. Nelson made his census for the Biological Survey and with the assistance of various reporting agencies concluded that there were 26,604 in the United States and 1,327 in Canada. Today, the fairly accurate but incomplete census as given on the following pages, places 68,392 in the United States and 2,400 in Canada.

As mentioned earlier in these pages, the outstanding zoological characteristic of the pronghorn lies in the fact that it possesses branched horns and that the horny sheath is shed and replaced each year. This process and the general characteristics of the change have never been fully understood. Farther on in this Bulletin Dr. Charles V. Noback discusses this change in the light of investigations which he has made at the Zoological Park.

Following is a report on the status of the pronghorn herds of those states from which we have received information. A comparison is made with the results of Dr. Nelson's survey in 1922-24.

Census of the Pronghorn

Compiled from figures furnished by officials of Forest and Game Preserves of Canada and the portions of the United States included in the natural range of the Pronghorn.

THE following census of the pronghorn as made by the Bulletin represents an attempt to estimate its numbers as accurately as possible through an inexpensive long-distance survey. In several instances the figures given, represent the exact number of animals in the state at the time the census was made. In general the figures are believed to be reasonably accurate. Several estimates, while official, are apparently too optimistic and should be reduced considerably in order to agree with more conservative reports on the same areas received from other sources.

It should be understood that it is exceedingly difficult to determine with any degree of certainty, the exact numbers in the widely scattered herds ranging over the vast areas of the territory involved.

The fact of greatest interest is, however, that

the pronghorn is increasing; thus its future bears a certain assurance of safety. This is a matter most gratifying to wild-life conservationists.

Appended is a list of the states from which information was received, with extracts from letters concerning the pronghorn herds and their estimated numbers in the state. In each instance a comparison is made with the census figures compiled by Dr. Nelson in 1922-24. States which failed to reply to our communications are not listed in the census.

We wish to thank the following organizations and officials who so kindly cooperated in making this survey.

CANADA

Hon. J. B. Harkin, Commissioner, National Parks of Canada.

UNITED STATES

Dr. W. B. Bell, Bureau of Biological Survey.
C. E. Rachford, United States Forest Service.
Horace M. Albright, Director, National Park Service.
M. E. Musgrave, United States Forest Service.
Leo K. Wilson, Division Fish and Game, California.
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Marshall N. Dana, Associate Editor, The Oregon Journal, Oregon.
M. S. McMurtery, State Game Warden, Oklahoma.
J. T. Scott, President, State Game and Fish Commission, Wyoming.

CANADA

Dr. Nelson, 1922-24. 1,327 Bulletin, 1932. 2,400

In Canada a number of small wild herds are found in Saskatchewan and Alberta. Of a total of approximately 2,400 animals about 400 are found in the two National Parks set aside as antelope reservations.

The first sanctuary was established in 1914. This later became known as Wawaskesy Park. It is located in southern Alberta about 75 miles south of Lethbridge and has an area of about 54 square miles. In 1915 the Dominion Government established the second reservation known as Nemiskam National Park. This area is about 25 miles north of Medicine Hat and contains about eight and a half square miles. It is a fenced preserve and it is therefore possible to keep a definite record of the progress made in that area. According to reports, the approximately 400 animals in this Park are, in the main, descendents of the original forty-two animals fenced in the preserve.

"At Wawaskesy National Park, as far as the observations of those in charge of the park show, the antelope which frequent this unfenced reserve are increasing. Concentrations of these animals are noticeably greater throughout the area than previous to the establishment of the park and their future in this part of the province appears assured".

ARIZONA

Dr. Nelson, 1922-24. 651 Bulletin, 1932. 7,500

"There are no antelope refuges in Arizona but those animals have enjoyed full year-round protection for many years and have increased materially in the past ten years. A conservative estimate of the number of antelope in Arizona would be between 7,000 and 8,000 head, about 5,500 of which range on National Forests or along their borders, in places summering on the Forest and wintering on the public domain or private lands.

Through the necessity of self-protection, antelope have changed their habits in the last quarter of a century from a plains to a woodland animal. This does not mean that they do not still inhabit the plains but most of them are found ranging along the edge of forested areas where they can run for cover when danger approaches and we are finding them ranging in comparatively rough areas in the higher elevations of the Transition Zone.

Golden Eagles are perhaps the worst enemy, except man, that the antelope has. Last winter, we found where those predatory birds had killed 8 full grown antelope that had been caught in a snow storm and were unable to reach cover before they were broken down by the big birds.

So far, we have not had any epidemics that have depleted our antelope herds and the future of the pronghorn in the Southwest is very bright".

CALIFORNIA

Dr. Nelson, 1922-24. 1,057 Bulletin, 1932. 8,000

"We have two main areas where antelope are to be found in varying numbers. One herd is concentrated in the Mt. Dome section, in Siskiyou County, and the other is in northeastern Modoc and Lassen counties. In both these sections, the state maintains game refuges for their preservation and protection.

In the Mt. Dome secton, it is estimated that the herd comprises 1000 individuals. In the Modoc and Lassen area, the herd is considerably larger and numbering at the present time approximately 8000 individuals. Understand, though, that during the severe winter of 1931, a large number of these animals migrated from northwestern Nevada to California and in the spring failed to return, thus our supply has been greatly augmented.

During the past 10 years, there has been a material increase in the size of both herds. Apparently there are no prevalent or endemic or epidemic diseases in the herds.

The future for antelope in California looks very bright. As you undoubtedly know, the animals have completely changed their habitat. Whereas they were once to be found only in the open meadows and high mesas and were never found in close proximity to trees, they have shifted their habitat due to the conflict with the pursuits of man, to the juniper areas in the more rugged lava outcropping. This is a niche of no value to man except in those areas which are watered enough for the pasturing of sheep and cattle, therefore, there is very little conflict from an economic point of view".

COLORADO

DR. NELSON, 1922-24. 1,233 BULLETIN, 1932. 2,000

"In addition to twenty-two game refuges in various parts of Colorado, one refuge containing 65,000 acres has been set aside in the northeastern part of Colorado. There are estimated to be about two thousand antelope in the state most of them in northeastern Colorado, although they range south and east to some extent. Settlers on prairie lands have forced the antelope out, and it is only by vigilant effort that we are able to maintain the present herds. They just about hold their own in numbers."

IDAHO

DR. NELSON, 1922-24. 1,485 BULLETIN, 1932. 4,000

"We have eighteen preserves for the protection of all game animals, located for the most part in the national forests. The antelope, however, has state-wide protection, and it is unlawful to hunt or kill this animal in Idaho. A recent check by the Forest Service fixes the number of antelope in the national forests as approximately 2,750 and we estimate that there are probably 4,000 in the state".

NEVADA

DR. NELSON, 1922-24. BULLETIN, 1932. 3,000 (inc.)

Census figures as received for Nevada are incomplete.

NEW MEXICO

DR. NELSON, 1922-24. 1,682 BULLETIN, 1932. 6,000

"A most conservative estimate of the number of antelope in New Mexico at the present time would be 6000 head, and I believe that we have many more than that.

A thorough study of our antelope situation would, I am sure, reveal some most interesting facts and should be made whenever we have the time available. One of the most interesting things in connection with the antelope herds in New Mexico is the fact that in the Black Range country antelope have penetrated right back into the heart of the mountains. You will find down on Diamond Creek, Tom Moore Canyon, and the Black Canyon Region, more than thirty miles from the nearest plains country, small herds of antelope ranging regularly in the timber and comparatively rough country adjacent to small open park areas. Antelope have been seen on the summit of Black Mountain, which is a high timbered area and serves as a lookout station for that part of the Gila Forest, and is located many miles from the nearest prairie land. Each year in the Black Range country deer hunters running onto antelope in the heart of the wooded areas have mistaken these animals for deer and killed them".

NORTH DAKOTA

DR. NELSON, 1922-24. 225 BULLETIN, 1932. 250

"There is one game refuge in North Dakota on which these animals are found. It is estimated that there are between 200 and 300 antelope in the state of North Dakota in several bands ranging in a number of counties south and west of the Missouri River. The number of these animals has been about stationary for several years".

NEBRASKA

DR. NELSON, 1922-24. 187 BULLETIN, 1932. 13

The only definite information received concerning the number in this state is that 13 are on the Niobrara Reservation.

OKLAHOMA

DR. NELSON, 1922-24. 23 BULLETIN, 1932. 16

There are no wild pronghorns left in the state of Oklahoma. There are two reservations with a total of 16 animals.

OREGON

DR. NELSON, 1922-24. 2,039 BULLETIN, 1932. 9,000

Since part of the Oregon antelope herd ranges south into Nevada and California some of the animals have been credited to those states. It is generally reported that the number is increasing.

"The chief protection for the antelope now is the fact that shooting is forbidden and that they are now in the desert country not much visited. We have intervened numerous times to the United States Biological Survey for assistance in establishing an antelope reserve but have been told that no money is available. The herd which also ranges in northwestern Nevada is, I believe, the largest at the present time in the United States".

SOUTH DAKOTA

DR. NELSON, 1922-24. 680 BULLETIN, 1932. 400

"One antelope preserve under fence, approximately 10,000 acres in area located in Harding County in the northwest extremity of our state. The preserve has been in existence but four years and thus far the annual increase has been about what could be expected from antelope at large.

Up until ten years ago, the antelope were rapidly decreasing, due to the settling up of their range, placing a large portion of the land under cultivation. Adverse conditions have compelled many farmers and ranchers in the northwest corner of our state to abandon their land holdings during the past ten years, resulting in that section reverting to a more or less open range country, and as a consequence wild antelope in the area are showing a marked increase, thus minimizing the necessity of maintaining a preserve".

UTAH

DR. NELSON, 1922-24. 670 BULLETIN, 1932. 800

"Our antelope are very sparse indeed, consisting of three small herds in the western part of the state and one small herd in the northeastern portion. These animals have only been "holding their own"; for a number of years there has been no decided increase and no decrease.

Limited watering places in our western desert makes it possible for us to get a fairly accurate count. We believe that we have in the neighborhood of 800 antelope in the entire state".

WYOMING

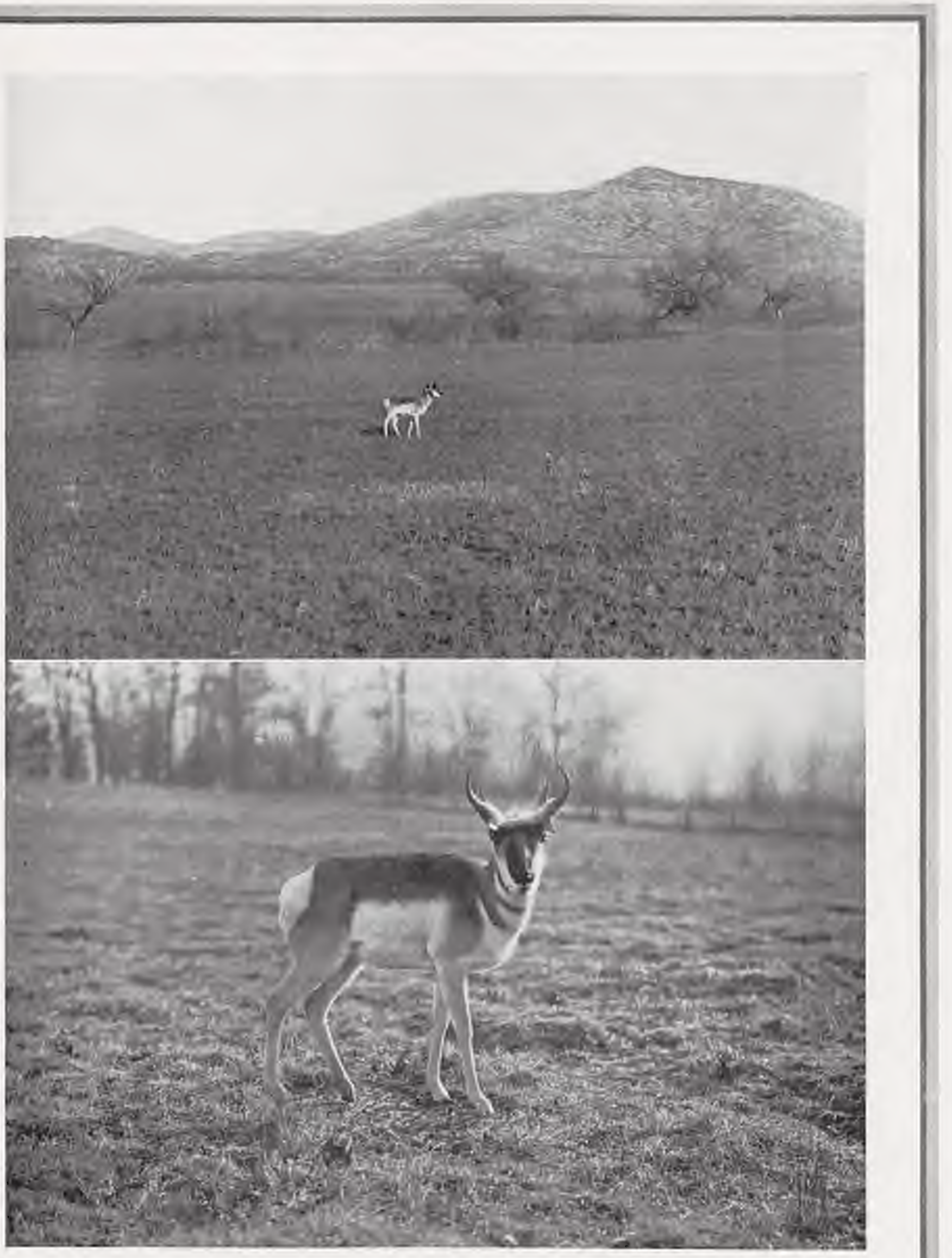
DR. NELSON, 1922-24. 6,977 BULLETIN, 1932. 25,000

Mr. J. T. Scott, President of the Wyoming Game and Fish Commission, states: "Twenty-five thousand antelope estimate conservative for Wyoming herd".

An unofficial estimate places the number in the state considerably under the above.

Census—Forest Service: As a matter of information and for comparison with the preceding census, The United States Forest Service states that 12,725 pronghorns were estimated to be on National Forests in 1931. These animals are of course included in the above figures.

An early herd of pronghorns at the Zoological Park. Photograph taken in 1902. The pronghorn is one of the most graceful of all animals and its long, lithe limbs carry it over the ground with a speed that gives it the distinction of being the fastest American mammal. None of the predatory animals can catch it under ordinary conditions, but in the heavy snows of winter it sometimes falls an easy prey to its enemies.



Above. Pronghorn on the Wichita National Game Preserve at the time of establishing the original herd of bison presented by the New York Zoological Society in 1907. *Below.* Another pronghorn from one of the early Park herds. Photographed in 1903.

Above. The pronghorn herd in 1902. *Below*. A fine male pronghorn, the leader of the first herd. Note the single prong on each horn. In fighting for herd leadership the male uses the prong as a guard and deftly parries the thrusts of his antagonist. Serious injuries are sometimes inflicted by the sharp point of the horn.

Two male pronghorns from an early Park herd, 1902-05. Because of their nervous temperament pronghorns sometimes suffer ill effects from the long journey to the Park. Apparently these animals can not be acclimatized in the humid, coastal climate of New York City. Efforts to keep them on exhibition have been temporarily discontinued.

The last herd of pronghorns on exhibition at the Zoological Park. Several of the Park herds contained young animals. They are endearing little creatures and in captivity are particularly tame and inquisitive Soon after some young pronghorns were placed on a reserve in the Grand Canyon, a photographer sought to take their picture. He could see nothing on his ground glass and, looking up, found a doe licking his lens.

(*Above*) Pronghorn, Nemiskam National Park, Canada. The male on the right is somewhat suspicious of the process of having his photograph taken, and has slightly elevated his white rump patch, the "chrysanthemum." (*Below*) A trio of young pronghorns in the Nemiskam National Park. Photographs by courtesy of National Parks of Canada through the Hon. J. B. Harkin, Commissioner.

Fig. 1. Head of a mature pronghorn that was exhibited in the Zoological Park some years ago. The photograph is an excellent illustration of the position of the horns on the head, and clearly shows that the prongs project over the supraorbital ridges which are directly above the eyes.

The Deciduous Horns of the Pronghorn Antelope
Antilocapra americana

Charles V. Noback
Department of Comparative Medicine, Zoological Park

Illustrations from photographs made in the Zoological Park

THE Pronghorn Antelope of North America, though not as widely known as the American bison (Buffalo[1]) is a truly representative American mammal. Fossil remains of prehistoric mammals closely related to the comparatively few living pronghorn antelopes have been found only in western North America and in Mexico. It therefore seems reasonable to consider the American pronghorn as distinctively American both in its origin and habitat. Since the pronghorn antelope possesses branched deciduous horns in addition to other unusual characteristics, zoologists have placed it in a separate family—the Antilocapridae—with but one genus—of which it is the only living representative.

The existence of the pronghorn antelope was probably brought to the attention of Europeans for the first time during the period of the Spanish Conquest of the New World by some of the Conquistadores who ventured into the regions of the Far West. Torquemada, writing in his work "Monarquia Indiana," published in 1723, gives an account of a great hunt, made in honor of Antonio Mendoza, Viceroy of Spain, which took place in the year 1540 in the northwestern part of the state of Hidalgo, Mexico. It took the form of a great drive of game by the Indians, during which, Torquemada states, "600 deer were killed, among which were large stags and those called 'verrendos'." Regarding the verrendos, the author stated that "they not only ran but flew and were unknown in Spain." These, the verrendos, were later to be identified as pronghorn or American antlope. According to Nelson[2] the pronghorn antelope was apparently seen for the first time by Europeans about 1540, as mentioned in the preceding account.

Although the earlier explorers had probably seen and apparently knew of the existence of these unique animals, none of them, however, brought specimens back to the settled eastern states. The scientific world is indebted to Lewis and Clark for the very first specimen of pronghorn antelope brought back to civilization from the Northwest in 1804. Audubon and Bachman (1851) were among the first naturalists who had observed the pronghorn antelope in its native habitat during the summer months. The earlier naturalists recognized that the horns of the pronghorn were branched, which characteristic gave this animal its name. They did not, however, recognize another very important characteristic of this strange mammal, and that was that its horns are shed periodically during the autumn of each year, notwithstanding that soldiers at Fort Union and the natives called their attention to this important fact. (Caton[3]).

This distinctive American mammal is found nowhere else in nature except in its immediate habitat in the western part of North America and in Mexico. Extreme shyness renders it very difficult to study. Its large, clear, dark limpid eyes are alert, keen-visioned and quick to discover any unusual object. Highstrung, nervous and swift, the pronghorn antelope has succeeded in eluding most of its enemies except man with his high-powered rifles and cold steel bullets.

The pronghorn antelope stands about three feet high at the shoulder and a few inches higher at the rump, being not quite as large as the white-tailed or Virginia deer but more compactly built. Its branched horns stand out prominently, the prongs projecting over the supraorbital ridges just above the eyes. (Fig. 1)

Its body is yellowish brown to a dull rufous yellow except for white hair around the rump, abdomen and neck. The white hair of the neck is girdled by a band of tawny-colored hair. The white rump patch stands out very prominently, especially when the pronghorn is excited and, when the antelope is in flight is clearly visible long after the animal is hardly distinguishable.

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1 The name "buffalo", commonly used to designate the bison of America, is a misnomer. The bison—of which there are but two species—the American and European (Wisent) is distinguished from the true buffaloes by the hump at the shoulder.

2 Nelson, E. W. Status of the Pronghorned Antelope, 1922-1924. U. S. Dept. of Agriculture, Department Bulletin No. 1346. Govt. Printing Office. 1925.

3 Caton, John Dean. The Antelope and Deer of America. Hurd & Houghton, Riverside Press, Cambridge, Mass. 1877.

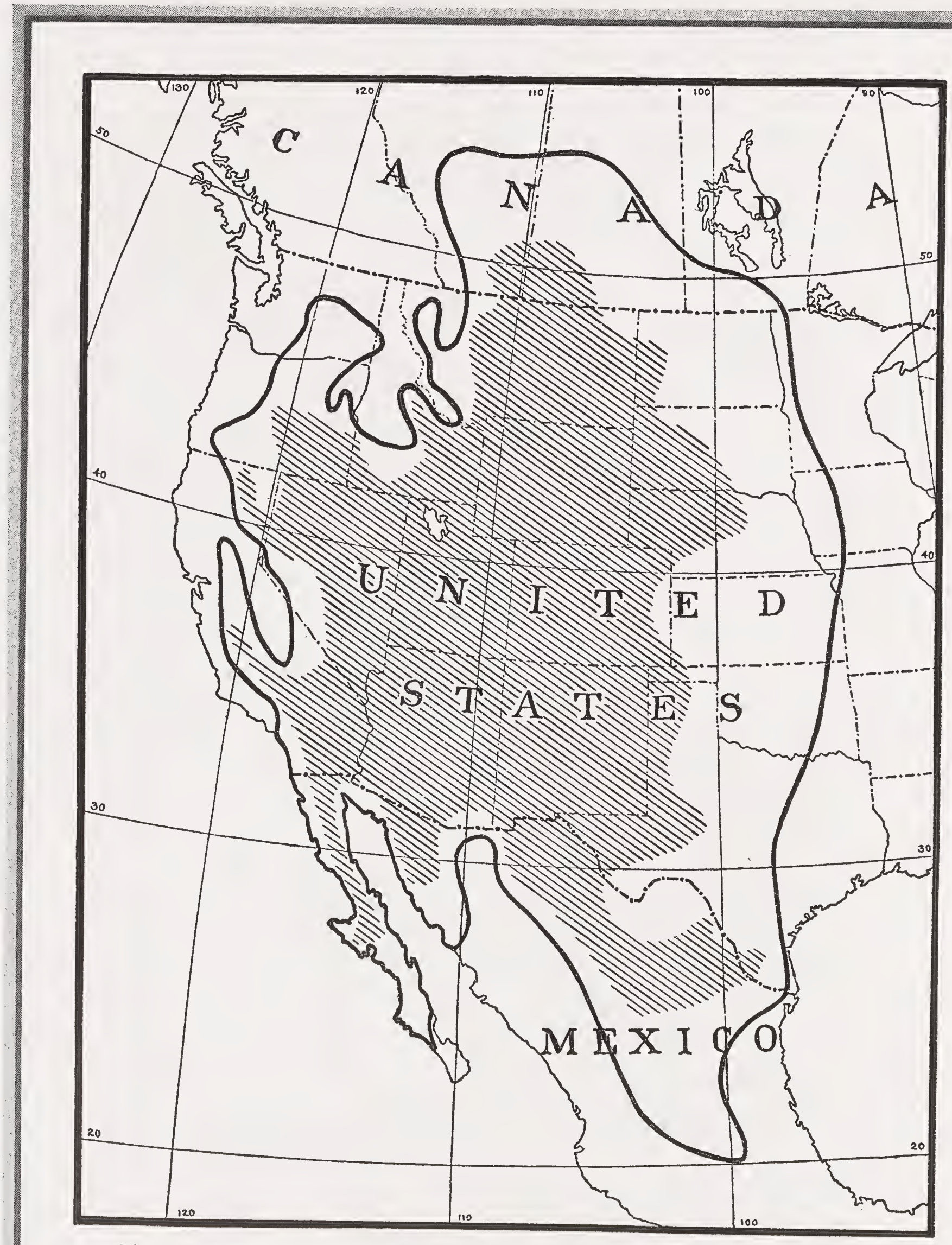


Fig. 2. Original and present distribution of the pronghorn. The black line marks the limits of the distribution before European settlements in America. The shaded portion indicates the area within which antelope are now found (1922-1924) in scattering bands. From Nelson, "Status of the Pronghorned Antelope, 1922-1924."

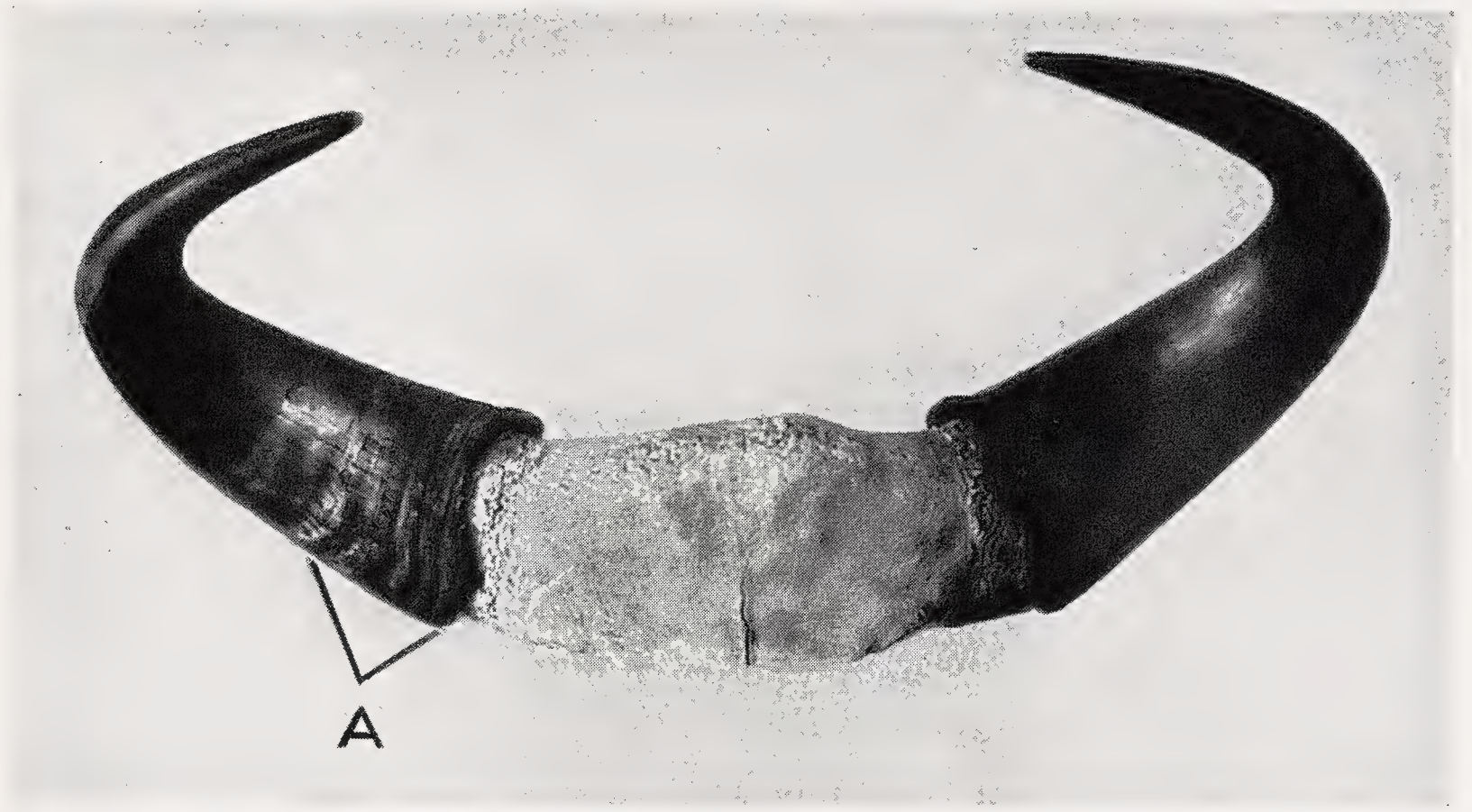


Fig. 16. Annular rings are present around the base of permanent horns in such animals as cattle. Generally speaking, each of these rings represents a year's growth in the permanent horn. A number of these growth-rings appear in this illustration, and at the point A, indicated by the two lines, they may be clearly seen.

With reference to the geographical distribution and the present-day status of the pronghorn antelope, Nelson writes as follows:

"Subsequent occupation of the continent has shown that the pronghorn ranged over an enormous area. (Fig. 2) It occurred over parts of the present provinces of Manitoba, Saskatchewan and Alberta in Canada. In the United States it occupied the country from western Minnesota, Iowa, Kansas, Oklahoma and Texas, reaching the Gulf coast near the mouth of the Rio Grande and west to western Washington, Oregon and the Pacific coast in California. In Mexico it occupied the open plains country of the tableland south almost to 20° of latitude, nearly to the Valley of Mexico; also the western part of Sonora and most of Lower California.

"Through the occupation of its territory by man the pronghorn has become extinct in many of its former haunts, but it has survived in limited numbers over an amazing proportion of its original range in Canada, Mexico and in sixteen of the western states of this country.

"It has been estimated that not less than thirty to forty millions of pronghorns ranged over this original area. The recent census by the Biological Survey shows that only about 30,000 survive today (1922-1924)."

Before describing the process of horn shedding in the American antelope, let us recall that all of the tissues of the mammalian body are developed from three primary layers of cells. These three primary layers of cells are formed soon after the ovum has been fertilized. The outer layer of these cells or the ectoderm, gives rise to skin, hair and nails, which are technically known as ectodermal structures. The middle layer, or mesoderm, gives rise to ligaments, connective tissue and bones, or mesodermal structures. The inner layer or endoderm, gives rise to the lining of the digestive tract and other endodermal structures.

The outer layer of skin consists essentially of a horn-like substance called the corneum or horny layer. The corneum is composed of a hard protein substance, keratin, a scleroprotein, which serves to protect the underlying delicate skin structure. Claws, nails, hoofs and horns are, practically speaking, specialized extensions of the corneum.

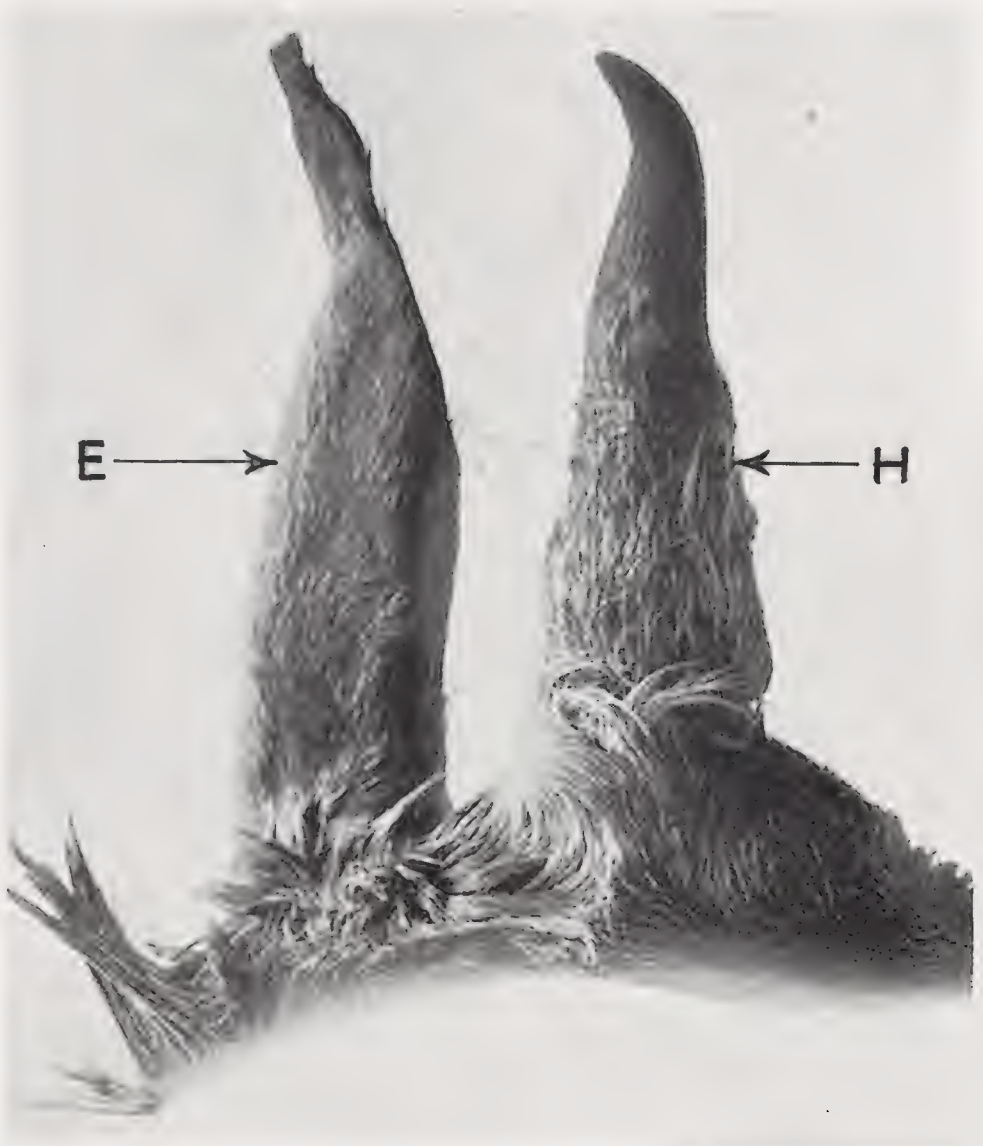
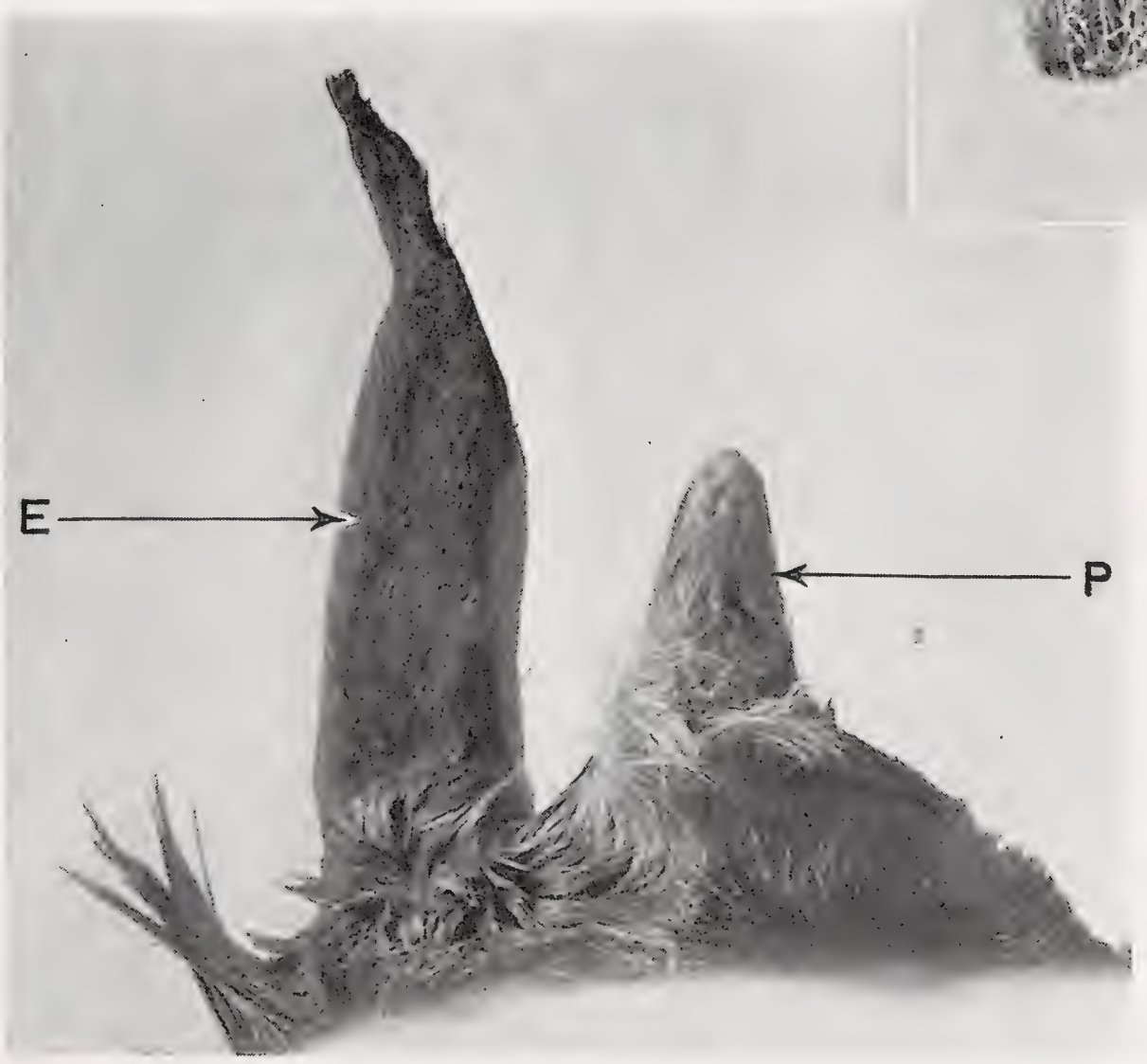


Fig. 3. (*Upper*) The general appearance of the concha or external ear (E) and the horn (H) in a young male pronghorn. The concha and horn project vertically from the top of the head and are parallel. The whorl of hair arising from the skin as it swirls around the base of the horn is quite distinct. Numerous hairs enmeshed in the horn substance are visible in the lower portion of the horn. The budding prong is not clearly visible in this picture. One-half life size. Fig. 4. (*Right*) A close view of the horn of a young pronghorn (as it caps a skin-covered bony pedicle) with the base hidden from view by the whorl of hair is shown at the right. This whorl of hair arises from the skin which covers the pedicle and hides the base of the horn. Life size of horn is four inches, as shown in the illustration.

Fig. 5. (*Lower*) During the fall (October) the horn of the pronghorn may be readily separated from the skin which envelopes the bony pedicle. At this stage if the horn is removed by gentle traction, the skin from which it arises is clearly visible. This specialized skin envelops the (P) bony pedicle which is an extension of the frontal bone and is situated over a hollow vault designated the lateral sinus in a succeeding illustration. One-half life size. Fig. 6. (*Right*) The conical-shaped horn with hairs enmeshed in the walls of its base can be seen in the accompanying figure. Its upper solid portion terminates in a tapering tip which gracefully curves backward. The dark knob seen in the upper third of the horn is a budding prong. Life size.



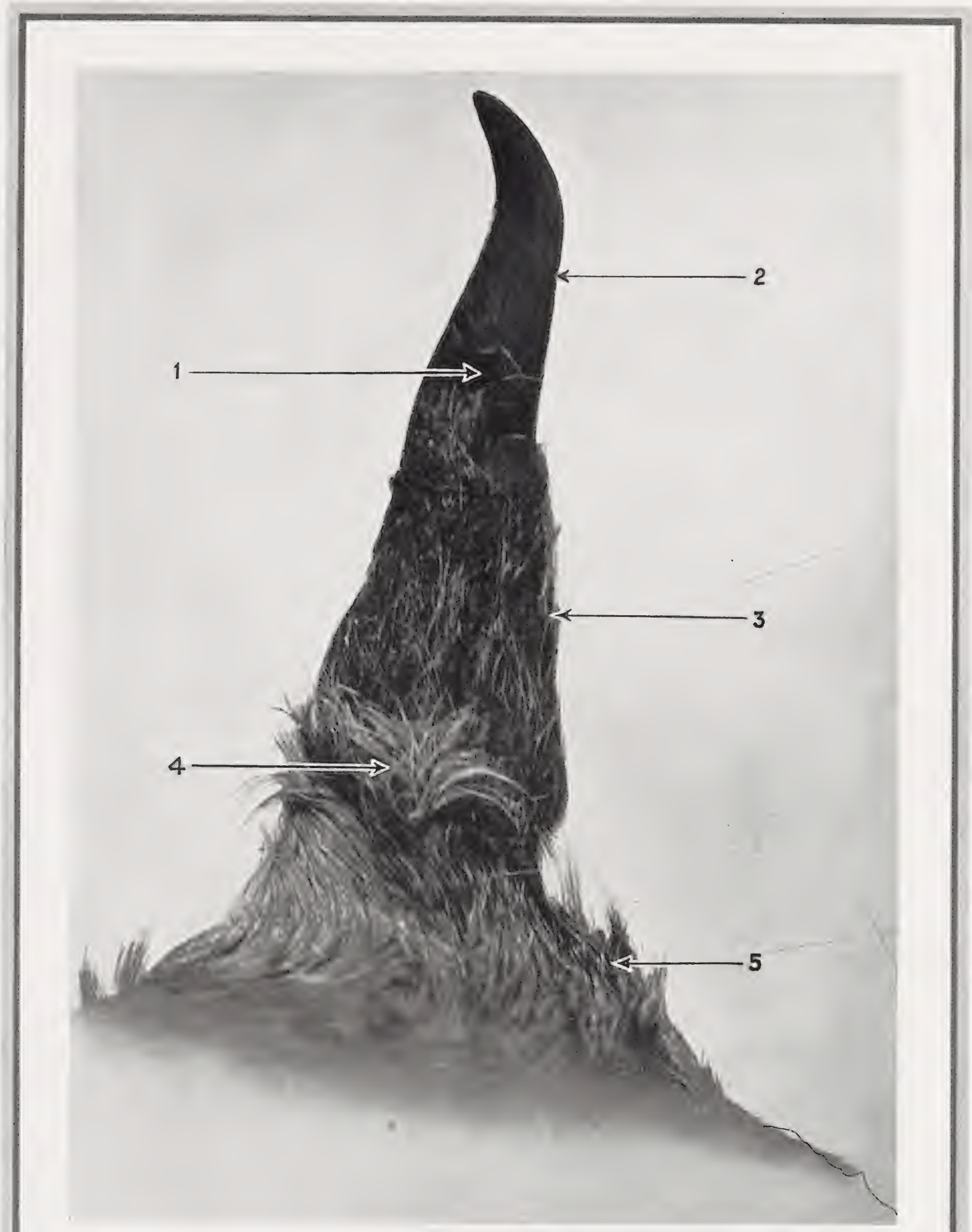
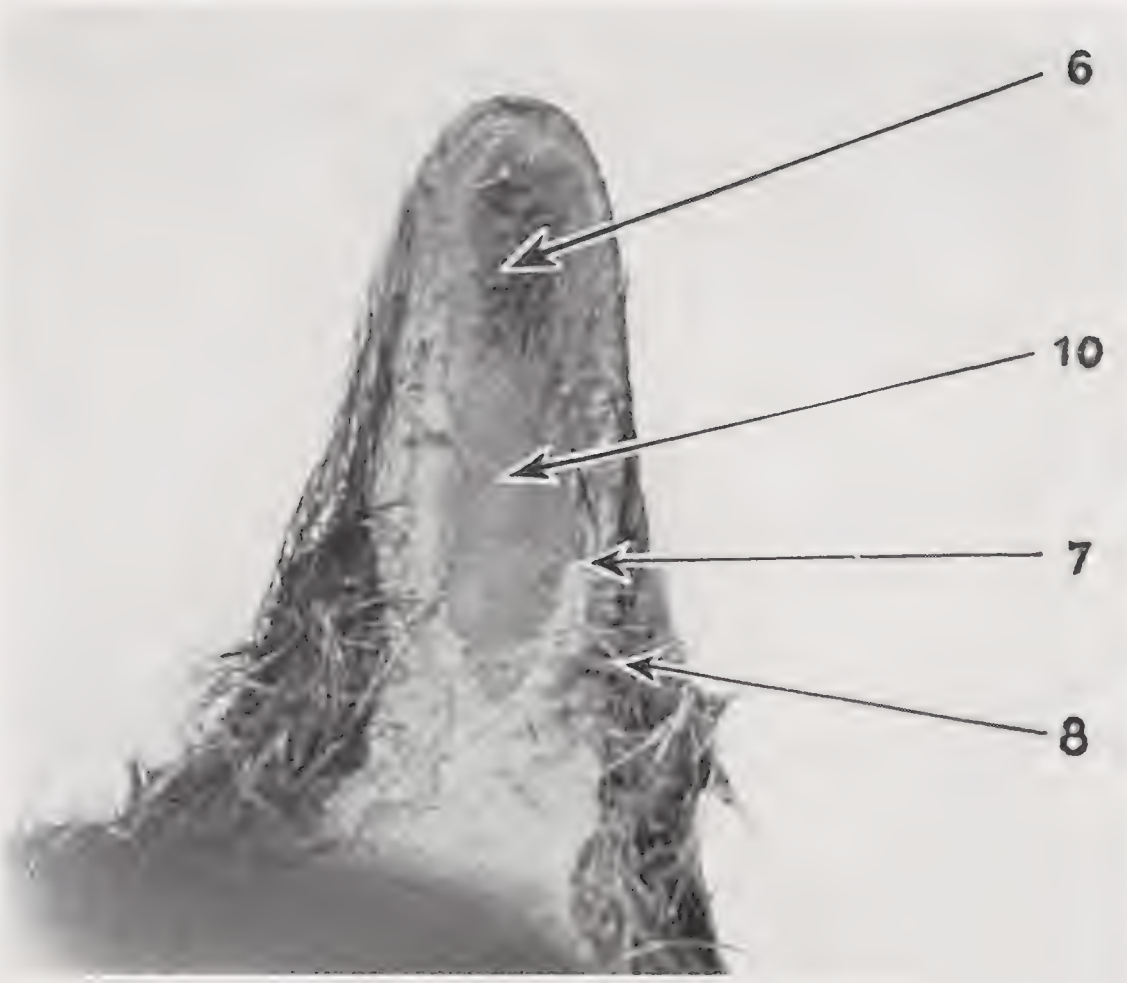


Fig. 7. This figure (external view of the horn and pedicle) and figure 8 are used to show the external appearance of the horn, a sectional view of the interior, and the relation of the horn and pedicle to each other. 1. The knob in the young specimen shows the budding prong, which is fully formed in the adult specimen. 2. The compact smooth tip of the horn which curves gracefully backwards. 3. The lower third of the horn with enmeshed hairs. 4. Whorl of hair around the base of the horn. 5. Hair and skin of the head below which the frontal and lateral sinuses are located. A sectional view of the horn, the specialized skin from which it arises, the bony pedicle and the sinuses below the bony pedicle. See figure 8.

Fig. 8. 1. The horn-knob in an immature horn. 2. The solid upper portion of the horn. 3. The lower border of the horn is here shown because the horn had been raised by gentle traction from the pedicle in order to show its relation to the skin covering the bony pedicle. 4. The skin of the head with hairs which cover the base of the horn. 5. Skin and hair covering the head. This skin does not develop horn. 6. The spongy, relatively soft membranous bone forming the bony pedicle above the lateral and frontal sinuses. 7. The specialized skin from which the horn originates covering the membranous bony pedicle. 8. The skin of the head as it merges in with the specialized skin of the pedicle. The lateral sinus is the spherical cavity below the pedicle while the frontal sinus is just in front of it.



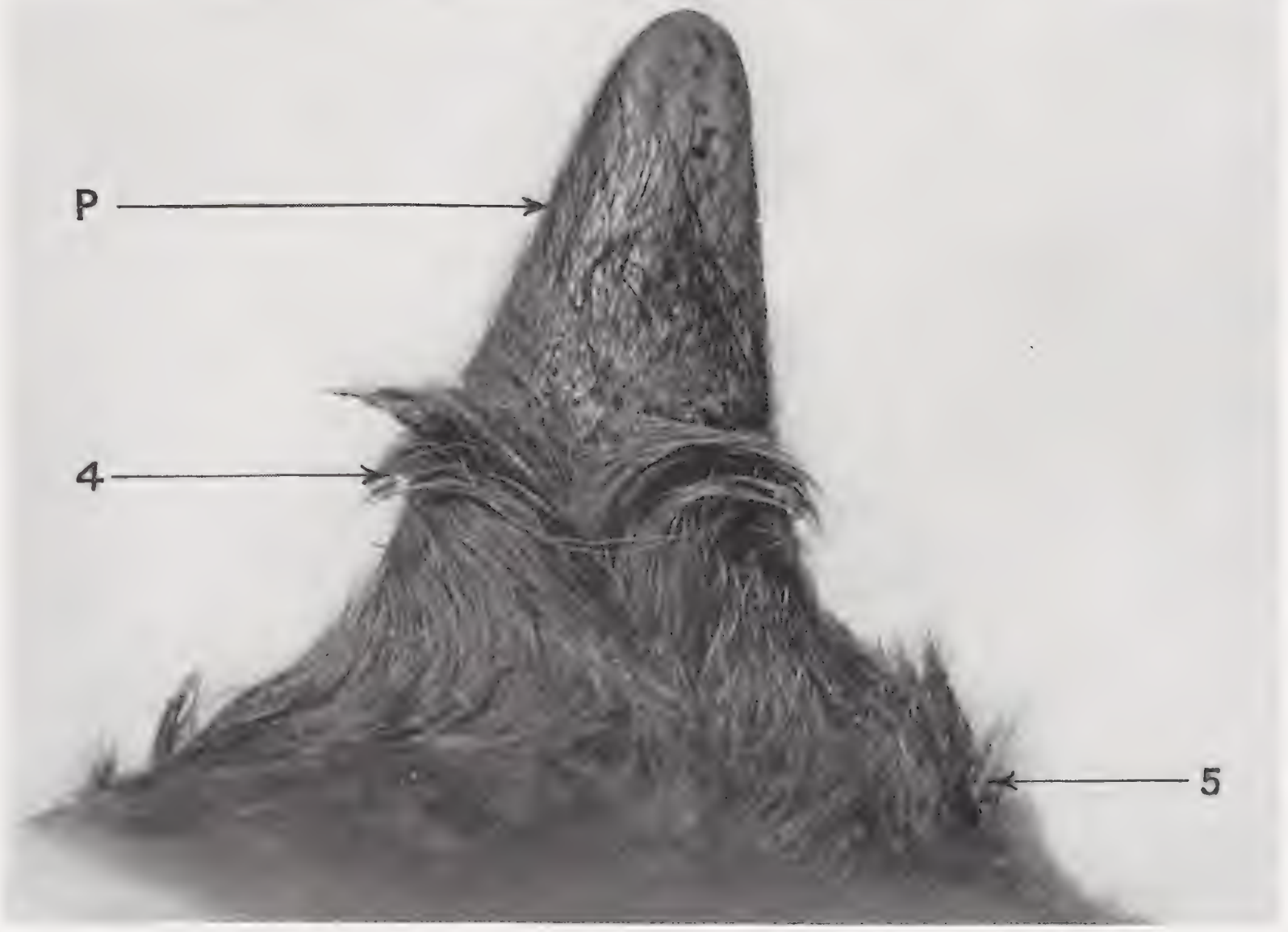


Fig. 9. (*Upper*) Internal appearance of the pedicle. 6. The spongy membranous bony pedicle, internal view. 7. The membrane covering the spongy, bony membranous pedicle, apparently the inner layer of the specialized skin enclosing the pedicle. 8. The skin of the head. 10. The hard outer portion of the bony pedicle. Natural size. Fig. 10. (*Lower*) The skin-covered pedicle with the whorl of hair around its base. P. This arrow is intended to point to the internal membranous bony pedicle. The skin as shown is the specialized skin from which the horn has been removed. This skin is covered with many fine hairs. It is this hair which apparently becomes enmeshed in the keratin or corneum of the skin as it develops into a new horn. 4. Whorl of hair. 5. Hair on skin of head. Actual size.

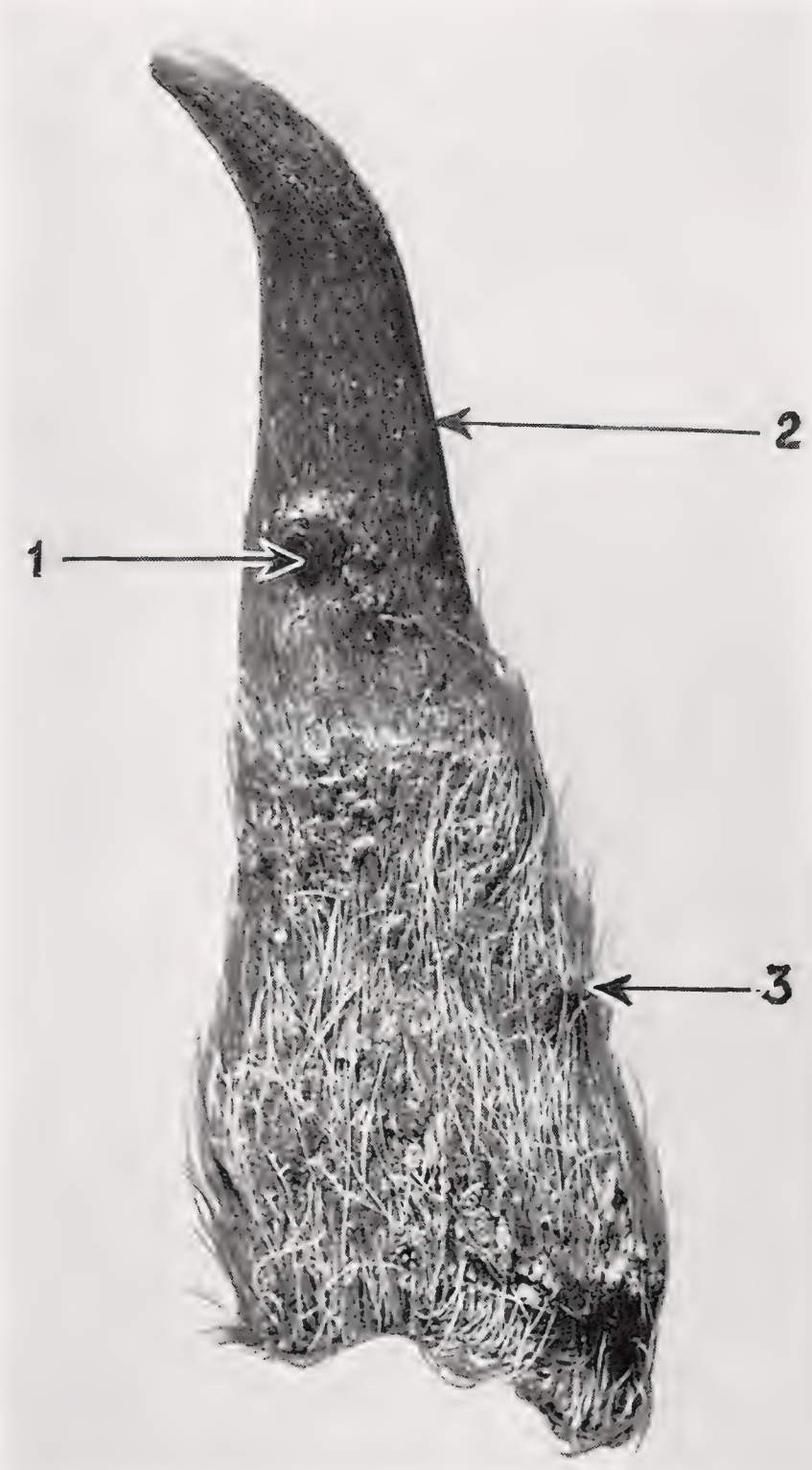


Fig. 11. (*Left*) 1. A knob-like button of horn is the nucleus of a budding prong. Since the specimen from which the horn was obtained was very young it did not develop a fully formed prong such as is seen in adult specimens. 2. The hard, finer grained tip of the horn which inclines backward. 3. Apparently as the horn develops from the corneum of its specialized skin, hairs become enmeshed in it. Life size.

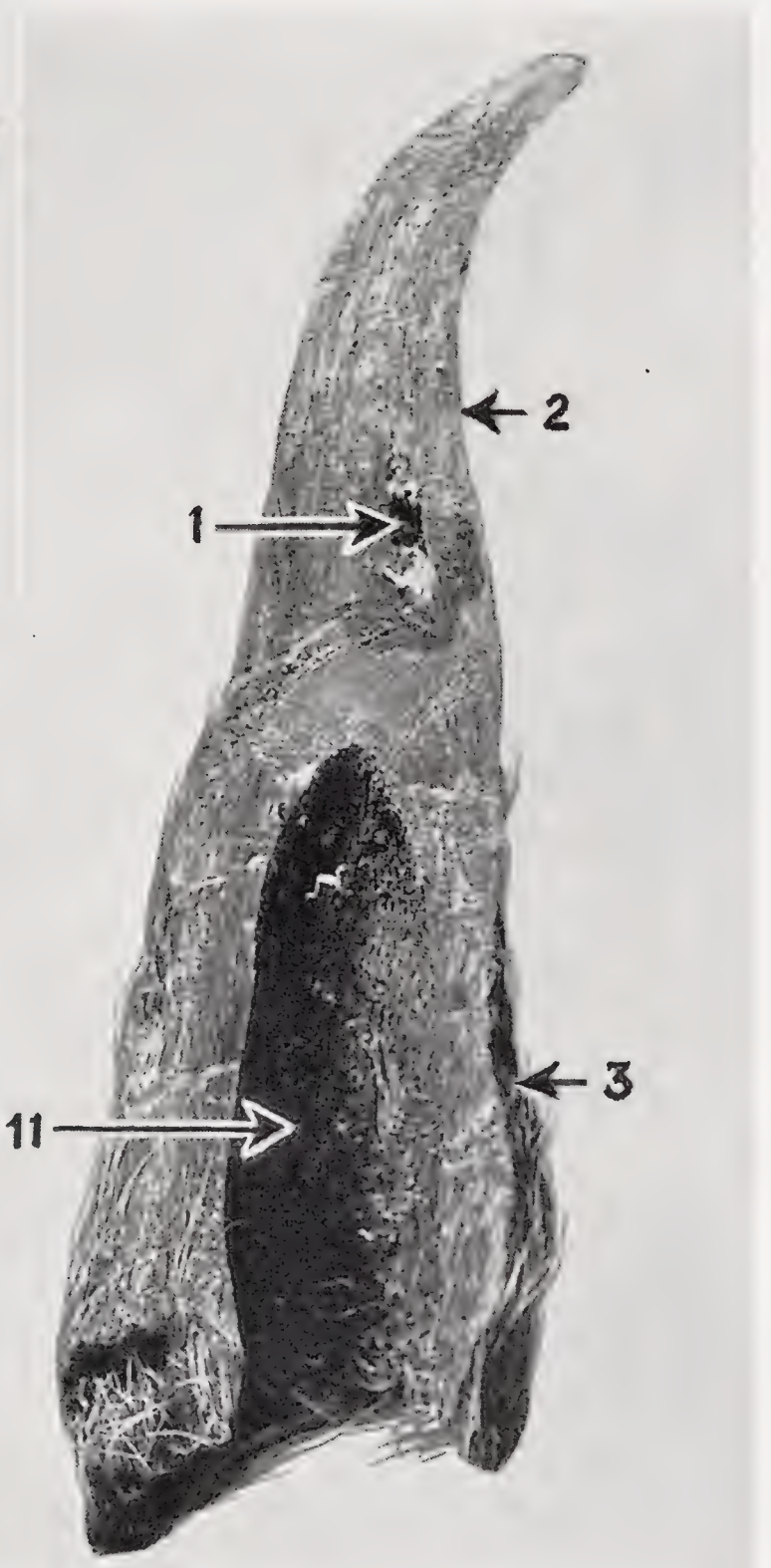


Fig. 12. (*Right*) After the shed horn has been cut lengthwise its internal gross structure is visible. 1. A cavity in the upper third of the solid horn which is just below the knob of a budding prong. 2. The solid portion of the horn. 3. Wall with hairs enmeshed in the horn substance (keratin). 11. The cavity of the horn which fits over the skin of the conical-shaped pedicle. Natural size.

Fig. 13. (*Upper*) Is a good illustration of the mature horns of the pronghorn, showing the full development of the prongs. Fig. 15. (*Lower*) is the same specimen with one horn removed to show the skin cap which covers the bony pedicle. The new horn apparently grows from this skin cap. Fig. 14. (*Center*) Shows the bony pedicle A, the skin cap C and the horn B, respectively. The records of these adult specimens were made in the Zoological Park several years ago by Elwin R. Sanborn.

The horns of the pronghorn antelope are clearly differentiated from those of such other horned mammals as cattle, sheep, goats and antelopes by three characteristics:

1. The horns are branched.

2. The horns do not possess annular rings around the base as do the horns of animals which possess permanent horns, such as cattle or antelope. In observing the permanent horns of cattle, for instance, one can readily see that as the horn grows from the skin at its base a new ring forms at the base each year, forming the annular rings. By counting these rings or ridges one can closely estimate the age of the animal. (Fig. 16)

3. The horns of the pronghorn are shed and renewed each year, consequently no such ring formation takes place. They are relatively softer than those in cattle or antelopes, and do not take on as fine a polish as the finer grained horns of cattle.

It was not until 1855 that the first published record of the fact that the pronghorn sheds its horns periodically appeared as a part of the "Proceedings of the London Zoological Society", in an article by C. A. Bartlett, Superintendent of the London Zoological Garden. Caton in "The Antelope and Deer of America," published in 1877, on page twenty-six reports that Dr. C. A. Canfield of Monterey, California, sent a description of the process of horn shedding in the pronghorn to the Smithsonian Institution in 1848. It was not, however, published by the Smithsonian until 1856, one year after Bartlett's report appeared. Caton further relates on page thirty-three that "the source of this horn is the epidermis. This alone undergoes a change and is converted into horn while the body of the skin remains substantially unchanged."

During the fall of 1928, the writer had the opportunity of observing the deciduous horn of a pronghorn antelope during the process of shedding. The specimen observed was a young male in the New York Zoological Park, hardly more than a year old, whose horns were just beginning to branch because the prong was present as a small bud-like sprouting knob.

The horn, four inches long, stands out from the top of the head parallel to the outer ear or concha (Fig. 3). A whorl of hair, extending from the hair of the head, swirls around the base of the horn so that the union between the lower border of the horn and the epidermis is hidden from view. Fine bristles of hair protrude from the horny matrix in the lower third of the horn. It seems that these hairs become enmeshed in the horn substance as the horn grows and develops from the corneum of the specialized skin and are subsequently drawn up with the growing horn. The upper third, composed of true keratin, completes the conical-shaped horn as it tapers in a fine pointed tip which gracefully curves backward. (Fig. 4)

At the time the specimen in the Zoological Park was observed, it was noticed that the horn could be loosened from its attachment to the skin which covered a membranous bony projection or pedicle. The bony pedicle or bony core is actually a projection from the frontal bone of the skull. It should, however, be noted that the horn itself is an outgrowth of and attached to the skin of the bony pedicle and is not in direct contact with the bone itself. The bony pedicle is referred to as a bone core by Nelson.[2] Since the horn is a keratogenous structure it seems hardly possible that the new horn should develop from bone, as is apparently implied in the following quotation from Nelson[2]: "A new horn nucleus develops on the tip of the bony core, and the horny growth then extending slowly downward until it reaches the base." Flower & Lydekker[4] state that "when the horn is about to be cast off it becomes loosened, and a new one is formed upon the bony core beneath it." From the observations made by the writer and the fact that the horn is a keratogenous substance, it appears that the horn of the pronghorn is in direct contact with the specialized skin which in turn envelops or covers the bony core or pedicle.

The deciduous horn about to be shed was separated from the underlying skin by gentle traction. After the horn was removed a cone-shaped pedicle (Figs. 5-6) came to view. This pedicle has the appearance of a conical peak surmounting a hill-like bulge (lateral sinus) on the side of the head. Later examination revealed that this bulge was formed by an extension of the frontal bones which form the vault of a large lateral sinus. (Figs. 7-8) This sinus serves as an air cushion to protect the brain which is located deep in the skull. The base

4 Flower, William Henry and Lydekker, Richard. Mammals Living and Extinct. p. 333. 1891.

(*Upper*). One of the dovekies or little auks driven inland during the storm of November 19, 1932, and picked up exhausted in the Bronx. This is one of the fifteen little victims brought to the Zoological Park. It was afterward released on Long Island Sound. Photograph by E. R. Osterndorff. (*Lower*) Three other dovekies found at Jones Beach, Long Island. Mr. William Vogt, director of the Bird Sanctuary, is shown banding a dovekie preparatory to its release. Photographs by courtesy of Dr. Robert Cushman Murphy, American Museum Natural History.

of the pedicle is surrounded by the whorl of hair. The skin enclosing the pedicle or so-called bone core, clings firmly to the bone beneath it and apparently the corneum of its epidermis serves as the starting point (anlage) of a new horn. (Figs. 9-10)

The shed horn, which was photographed separately, as shown (Figs. 11-12) consists of true keratogenous or horn tissue, such as is found in all true horns. Hairs enmeshed in the horn substance can be seen in the lower portion while the upper part is particularly free from hair. A knob-like growth on the exterior part of the upper portion of the horn indicates a budding prong which is more prominent in the horns of an adult pronghorn antelope. (Fig. 13)

A longitudinal section of the shed horn reveals that it is hollow with relatively thick horn walls in the lower two-thirds while the upper part (Figs. 11-12) is solid with the exception of the hollow portion of the budding prong knob.

Photographs made several years ago by Elwin R. Sanborn (Figs. 13, 14, 15) show that essentially the process of horn shedding is the same in the adult pronghorn as in the case of the younger specimen studied by the author, that is, when the horn is shed it is separated from the specialized skin (skin cap) covering the bony pedicle. The new horn develops from this skin.

The shedding of horns by the pronghorn might be confused with the shedding of antlers in the deer, but one clearcut difference between the horn of the pronghorn antelope and the antlers of deer stands out clearly: The horns of the pronghorn are true horns, or ectodermal structures derived from the outer layer of the skin, while mature antlers of deer are not true horn or keratogenous structures, but are bony or mesodermal structures. The bony antlers of deer are shed in the spring while the true horns of the pronghorn antelope are shed in the fall.

The Dovekie Invasion

LEE S. CRANDALL
Curator of Birds, Zoological Park

INURED to the vagaries of New York weather, Traffic Officer Beckwith was stoically directing the slow movement of long lines of motor vehicles, at Pelham Parkway and Eastchester Road, in the outer reaches of the Bronx. It was early afternoon of the 19th of November, 1932, a particularly wretched day. A wind of but little less than gale force was rushing upon the city from off the sea, driving before it horizontal sheets of torrential rain. Visibility was reduced almost to its minimum; drivers felt their way with caution, each checking his own progress by that of the car directly ahead.

A New York policeman is expected to be prepared to handle any situation that may arise; it is, in fact, difficult to imagine an occurrence that would nonplus him completely. Consequently, when out of a burst of wind and rain, a strange bird dropped suddenly to the pavement at the feet of Officer Beckwith, there was no unseemly excitement. Sharp blasts of a whistle brought all traffic to a stop; all eyes were focussed on the cause of the interrupted flow. With praiseworthy caution, the policeman proceeded with his investigation. After some preliminary feinting, which convinced him that his proffered fingers were not in jeopardy, he picked the bird up and held it in his hands. It rested quietly, without struggling. So far, so good. But now what to do? Waiting motorists, becoming impatient, pressed without restraint upon the buttons of their horns.

Even the wretchedness of such a day could not prevent the formation of a crowd on any pretext, within the confines of New York, and already the usual ring of small boys and idlers had gathered. Quickly selecting two from their number, Officer Beckwith turned the bird over to one of them and bundled them into a westbound car, with instructions to stop at the Zoological Park. A blast of the whistle and the long lines again moved forward with their accustomed smoothness.

A minor incident in a great city's traffic, the dropping of this bird was of the greatest importance to us in the Zoological Park, for it was our first intimation that a major catastrophe had overtaken its race. The bird was a dovekie or "little auk" (*Alle alle*), a species that ordinarily

winters well out at sea. Its arrival at the Park signalized the beginning of a considerable procession of kind-hearted persons bringing rescued birds and a long succession of telephone calls, extending through the remainder of Saturday, all day Sunday and most of Monday. In all, fifteen birds, many of them dead, were brought in. All those who called by telephone were advised to liberate the birds in the nearest body of water, preferably salt, so that a large number of victims of the storm were given a chance to win back to the open sea.

Previously, only one dovekie has ever been received at the Zoological Park. This bird came aboard the old S. S. *New York,* of the American Line, on November 27, 1908, and was delivered to us when she docked here on the 30th. It was very weak and survived for only a day or two.

The dovekie is a member of the family Alcidae, which includes the auks, murres and puffins. It is a small bird, averaging somewhere about eight and one-half inches in total length; the wingspread of one measured here was fifteen and one-half inches. In the breeding season, the upper plumage is bluish black, with the sides of the head, throat and front of neck brownish; below the neck the under surface is pure white. There are narrow streaks of white on the edges of the scapulars, with a thin bar of white across the lower wing. In winter, the plumage is much the same, except that the brown on the head and neck is replaced by white, which extends partly around the nape.

The breeding range of this little bird lies along the coasts of the Arctic and North Atlantic Oceans, and various islands, including Baffin Land, northern Greenland, northern Iceland, Spitzbergen and Novaya Zemlya. It is extremely abundant and is an important source of food supply of the Eskimos, who catch the birds without difficulty in small hand nets, as they fly along the rocky shores.

At the end of the breeding season, the birds begin to work south and by November have reached their winter range. This includes coastal waters of the western Atlantic as far south as Virginia (casually to South Carolina), and of the eastern Atlantic to the Azores and Madeira. Commonly, the birds keep well out at sea, and there is much variation in their numbers, at given points, from season to season. Consequently, there are very few in-shore records; Griscom,[1] referring to the region of New York, states that "There are some twenty records in the last forty years."

Dovekies are hardy birds, ordinarily well able to fend for themselves in rough weather. Occasionally, however, a succession of severe storms may prove too much for them; unable to hold their own against the rush of wind and water, the helpless creatures may be blown inland, most of them to perish miserably.

Such a debacle occurred on the coast of New England on November 15th, 1871[2], during a heavy easterly storm. On that occasion, birds were reported from widely scattered inland points in Massachusetts and Connecticut. There appears, however, to be no record of any dovekie catastrophe approaching that of November, 1932.

This seems to have begun with a severe storm that occurred off the coast of New England, from November 7th to 10th. Dr. John B. May,[3] Director of Ornithology for the Massachusetts Department of Agriculture, reports as follows:

."... during and immediately after the period literally hundreds of dovekies were reported to this office as seen on inland waters, or picked up exhausted or dead on land. The aviary at Franklin Park received about thirty birds, nearly as many were sent to various humane societies for treatment, sanctuary protectors received many more .... The birds were noted from Maine to Rhode Island along the coast, and as far inland as Wolfeboro, New Hampshire, Worcester and Athol, Massachusetts, and west of Providence in Rhode Island. Then on November 19 came another storm from the south or southwest, and once more dovekies were reported by hundreds from Rhode Island, Connecticut, New York, New Jersey, and as far west as the Philadelphia region. This storm also brought records from the Connecticut Valley in Massachusetts .... Most of the birds died, either from exhaustion, injury or lack of proper food but a small group survived in the Mystic Lakes from November 11 to at least November 27."

The second storm to which Dr. May refers, as occurring on November 19, is the one which

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1 Griscom, Ludlow. Birds of the New York City Region, 1923. p. 65.

2 Brewster, William. Memoirs of the Nuttall Ornithological Club, No. IV, 1906.

3 Items of Interest, Massachusetts Department of Agriculture, December 7, 1932, p. 2.

caused the dovekie invasion of New York. The month had already brought us some bad weather, but that of the 19th was particularly severe. Official observers of the United States Weather Bureau, situated atop the Whitehall Building in downtown New York, recorded the wind velocity as increasing from thirty miles an hour in the early morning, to fifty-one shortly after noon. Its direction, at first, was from the southeast but it changed later to due south. From 4:00 A.M. to 3:25 P.M., when the rain ceased, the total precipitation was 1.49 inches.

It is reasonable to assume that the birds were blown inland on Saturday, before the wind subsided. A few, of course, were found on that day but more were discovered on Sunday, Monday or even Tuesday. Under ordinary conditions, the dovekie seems unable to rise from the ground, once it is down. At sea, it can take off from the tops of waves, or skitter along the surface for a running start. Mr. George Vogt, of the Jones Beach Bird Sanctuary, on the south shore of Long Island, reports a case in which a bird was carried to a concrete road, and was able to rise when headed into the strong wind. Most of the birds, less fortunate than this one, never took wing again, once they were down. From the large number of birds reported, one is able to grasp the immensity of the holocaust, since for every dovekie that was found, very many more must have escaped notice.

A timely story of the disaster, released by Director Blair, accompanied by a photograph of a living bird and published by the New York papers on the 22nd, was welcomed by many persons who had been unable to identify the birds they had found. It brought us, also, many interesting reports that otherwise might have escaped notice. Among these was a post-card from Mrs. Dorothy Binney Upton, of Fort Pierce, Florida, stating that she had found eleven dead birds and one that was still living, on the beach at Fort Pierce, on December 2. She believed the birds to be dovekies. The only evidence of the occurrence of the dovekie in Florida is a sight record of a single bird in the Indian River, established by C. J. Maynard, "presumably in 1871.[4] Hastily, we wrote Mrs. Upton, urging that some tangible evidence, if only the head or foot of one of the birds, be sent us in order to establish positive identification. In a letter dated December 13, Mrs. Upton replied:

"It is with some misgiving I sent you a box today with two very dead little bird carcasses in it. But as your note to me said you would be glad to have any remains, or even a head or a foot of what I think is the "little auk" found here on our Florida beach, I am taking you at your word and the postmen between here and there can rave all they like about odors and sachets! . . . On December 1, I saw one of these little birds up the Loxahatchee River (about twenty miles north of Palm Beach) alive and swimming . . . The following day here on the beach at Fort Pierce I saw eleven bodies and found one live specimen . . . several fishermen told me of having seen the strangers in the Inlet here or just outside the Inlet, in the ocean."

On the day after Mrs. Upton's letter was received, the box arrived. It contained the remains of two authentic dovekies, both, as we had been warned, quite definitely dead. They have been sent to the American Museum of Natural History, where they will be preserved as definite, if somewhat fragmentary, evidence of the record.

The farthest north of the reports received here came from Miss Miriam E. North, who identified a bird floating on a small pond near Meriden, Connecticut. One, also, was reported from Peekskill, New York. Miss K. Bausch, of Bloomfield, New Jersey, found one of the stranded dovekies on her lawn on the Saturday afternoon, and immediately set out in her car to take the bird to us. While waiting at the ferry in Jersey City, she discovered some small boys playing with another, which she promptly confiscated, and added to her collection.

The most detailed of the first hand experiences that have come to our notice was furnished by Mr. William F. Drescher, of New York City. Mr. Drescher has been good enough to write for us the following account:

"A strong wind blowing during the night of November 18-19, it occurred to me that there might be a possibility of some of the sea birds being driven close to shore and of probably being able to observe birds not generally found in this region. Accordingly I travelled down to Jones Beach on Long Island.

"Arriving at the Jones Beach Bathing Pavilion at 7:30 A.M., I not only found a strong wind but a gale blowing, with a very high sea

4 Florida Bird Life, by A. H. Howell, 1932, p. 275.

A Panamanian forest jungle. Strangler vines have enmeshed the great trees at the left of the picture. Varying in thickness from a slim cord to the diameter of a fire hose or a man's thigh, they encircle these tropical giants with a titanic grip. The tension which these vines exert is almost beyond comprehension. If severed with a machete, they part with the snap of a tightly stretched wire cable. Once a tree is wrapped its life is doomed. In the end only the vine exists.

running, and intermittent heavy rain squalls. Finding a lee in the shelter of the Pavilion, I adjusted my binoculars and began to scan the ocean and the beach in search of birds. Aside from a few herring gulls, there was nothing to be seen. On the chance that the gale might have driven the birds to the bay side of the beach, I travelled for several miles among the sand dunes in search of bird life. While thus wandering about, a small bird flew by overhead, and from the brief glimpse I had of it, noticing a black band under its neck, I judged it to be a semi-palmated plover.

"Continuing along the dunes, I reached the Jones Beach Bird Sanctuary, where I saw a dead dovekie lying on the doorstep of Mr. William Vogt's house. After a short visit I continued my walk among the dunes, when suddenly another bird flashed by close to the ground and seemingly disappeared in the bushes. Though I searched for some time, I could not find it. However, this time I was sure of the bird's identity, namely, a dovekie. From then on in my walk to the beach, an occasional dovekie flashed by, all flying close to the ground.

"At about 10:30 A.M., the first fairly large flocks of dovekies began to pass by. The largest of these flocks consisted of about fifty birds. Most of the flocks were not over ten or twenty in a flock. All of the birds seemed to be coming from a westerly direction and flying east. The majority of flocks flew close to the shore line and close to the ground. On many occasions I expected them to land on the beach, where of course they would have been helpless. But on every occasion they soared up again when they seemed to have been only a few inches above the beach. Those of the flocks flying over the ocean appeared to be skimming the wave crests.

"One small flock landed on the water and every moment I expected them to be smashed to pieces by the exceptionally heavy sea that was running. They bobbed about on the water like so many corks and at times appeared to be diving through the crests of the waves.

"Some flocks flew by fairly high above the water, probably one hundred to two hundred feet. The flocks came flying by intermittently for about two hours. In all, I judge that at least one thousand birds flew by during the two hours I was observing them. All were going in the same direction—west to east.

"After the last flight had gone by, only an occasional bird was seen. The last one I saw was on the Sunrise Highway, five miles from the ocean."

Of these hundreds, quite possibly thousands, of storm-blown birds, not all were so unfortunate as to fall helplessly on dry land. A few managed to drop into ponds or open waterways, from which they may have worked their way back to the sea. Three found themselves in a small salt water pool, only a few feet from the shore, on the estate of Captain Frank J. Walcott, at Great Kills, Staten Island. Captain Walcott believes one of the birds to have been taken by a hawk. The two others, apparently quite happy and seemingly able to find food, were observed at close range by many bird lovers, eager to make first acquaintance with a species so seldom seen. Captain Walcott reports that, about ten days later, the birds managed to rise from the pool and take wing towards the sea.

Of the living birds among the fifteen brought to the Zoological Park, only one survived for more than a few hours. This one had been found in the middle of Heathcote Road, at Scarsdale, New York, on the Saturday night, and taken to Dr. Ditmars, who kept it until Monday. It did not feed but seemed so bright and strong on its arrival here, that Dr. Ditmars agreed to take the bird to City Island, where he liberated it in Long Island Sound. When last seen by him it was swimming, rather uncertainly, toward open water.

It is difficult to account for our inability to keep these birds alive, by any other explanation than that they had suffered too greatly from exhaustion and lack of food before they were received by us. It is true that the normal food of the dovekie, as far as known, would be difficult to supply in captivity. A. C. Bent,[5] quoting W. E. Ekblaw, says:

"The food of the young dovekies is largely made up of the so-called 'shrimps' (*Schizopoda-Myris?*) so numerous in Arctic waters, and the so-called 'black-berries,' the little black 'arthropods' that are so numerous in the water too . . . . The food of the adult bird is probably the same as that of the young while they are in their summer home. This food it obtains in the sea, usually

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[5] Life Histories of North American Diving Birds. United States National Museum, Bulletin 107, 1919, p. 219.

Mountains of Panama. These mountains are the connecting links between the Rockies in the north and the mighty Andes of South America. From base to summit, their winding, undulating ridges are clothed with luxuriant verdure. Giant trees with pendulous masses of swaying moss tower above, and brawling torrents roar their way down the precipitous slopes to appear as silvery ribbons in the valleys far below. In the rainy season, the summits are wrapped in storm clouds, which as the burden of moisture is released in torrents of rain, rise and swirl like gracefully flowing draperies. This is the country of the bushmaster, which finds security and shelter in the outcropping limestone ledges of its mountain habitat.

most easily, apparently in certain currents, or about headlands, ice pans or ice bergs . . . ."

Among other authorities quoted by Beck, the consensus of opinion seems to be that the dovekie feeds chiefly on "minute crustacea." On the other hand, William Brewster, previously quoted, states that several dovekies killed on Fresh Pond, Cambridge, Massachusetts, during the invasion of 1871, were found to have been feeding on young alewives, a species of herring. From this it would appear that, specialized as the normal diet of the dovekie is, it nevertheless retains some ability to adapt itself to unavoidable conditions. While the birds here refused to touch fish provided for them, and could not be kept alive by forced feeding, it is quite possible that they were already too much weakened to be able to recover.

Consideration of the food habits of the dovekie leads us to speculation concerning the causes of this double catastrophe. At first glance it all seems simple enough: a long-sustained wind of high velocity, combined with a deluge of rain, was more than the birds could face and they were blown ashore. But rains fall and winds blow during every winter season, without bringing us showers of dovekies. Each year the birds are called upon to face conditions at least as severe as those of the 19th of November, and each year they triumphantly survive. On the other hand, the rate of metabolism in birds is much more rapid than that of mammals, as evidenced by the higher temperatures of the former. Periods of great exertion, without sufficient compensation in food, quickly exhaust them. Weakened by the three day blow off the New England coast, when feeding would no doubt have been difficult, the survivors were caught farther south by another storm of shorter duration but high intensity, before they had completely recovered. The second disaster resulted.

It is quite possible, of course, that some variation in food supply may also have been involved but as to this we have, as yet, no evidence. At any rate, there is no doubt that the birds received here were greatly emaciated. Fourteen of these were sent to the American Museum of Natural History on November 22. With four others, they were weighed on that day by Mr. Charles O'Brien of the Department of Ornithology of that institution, with the following results: average for eighteen birds, 3 ounces; minimum, 2½ ounces; maximum, 3¾ ounces. While, unfortunately, we have found no weights of normal birds with which to make comparison, it is obvious that after making allowance for bones and feathers, the remainder would be poor comfort for a hungry Eskimo.

In Quest of the Bushmaster

RAYMOND L. DITMARS
Curator of Mammals and Reptiles, Zoological Park

Illustrations from photographs taken by Elwin R. Sanborn during a trip to Barro Colorado, Panama under the direction of the New York Zoological Society.

THE American tropics form the home of the world's largest viper, the Bushmaster, Surucucu or Mapepire Z'Ananna, *Lachesis muta*. The Spanish-speaking natives sometimes call it La Cascabela Muda (the mute rattler) as it vigorously shakes its tail, when angry, the tip fading into blur of motion as rapid as that of the specific caudal appendage of the rattlesnake. The bushmaster grows to a length of twelve feet. Its pattern is particularly vivid owing to its body hue of pale or pinkish brown, sometimes the shade of salmon. Along this body, rather widely spaced, are broad black bands. The body scales are rough, and protrude as knobby points like the surface of a wood rasp or in reduced replica of the skin of a pineapple. Hence one of the names, Mapepire Z'Ananna, signifying the resemblance of the bushmaster's scales to the skin of the rough fruit.

The bushmaster's head is heavy and blunt. Its canaliculated, venom-conducting fangs are enormously developed—two inches in length with a big specimen. The species is a particularly insolent snake, not actually gliding into attack, but without inclination to retreat from the human intruder. Its attitude, in fact, is to edge in closer, while more widely forming its lateral striking loops to lurch its fangs at an offending object. It has always been very rare in collections. But three specimens have been on exhi-

Howler Monkeys. This is the largest monkey of the American tropics, the big males being the equal in bulk of a medium sized Old World baboon. This species is largely nocturnal, and the mournful howls and roars of a band of these monkeys in the silence of a tropic night is surely an awsome sound. It is truly beyond the comprehension of the layman to understand the kind of animal that can produce a noise so formidable. A band of the howlers may be seen in the lofty tops of the trees, perched at perilous heights on structures so frail as to seem of insufficient strength to bear their weight. Yet they leap across great spaces, trusting to hands, feet and the long prehensile tail for a firm clutch and none seem to fall.

bition in the Park in over thirty years. The snake has had the reputation of being rare throughout its habitat.

A year past, the writer was surprised to hear that seven bushmasters had been killed in and around the area then being cleared for the Madden Dam, an engineering project to provide additional water for the Panama Canal. This area is about fifteen miles from the Canal Zone, and situated in the valley of the Chagres River.

The United States negotiated with the Panamanian Government to secure a strip of land leading to the site of the Dam, and built an excellent cement road to the area of construction. This road winds inland from the location of the Pedro Miguel locks. The building of this road has been of great interest to tropical research workers. It leads through virgin forest-jungle, can be quickly negotiated by automobile, and a stop anywhere along the greater portion of its length offers alluring opportunities for observation.

With this prospect in mind, and being in receipt of several invitations to visit the area, the writer left New York in August, on the United Fruit Company's vessel, the "Calamares." The trip was not of formal arrangement, nor was there opportunity to remain away longer than three weeks. It was, in fact, a vacation trip, in the nature of a preliminary reconnoiter to more extensive investigation during 1933.

Through the courtesy of General Harry Burgess, Governor of the Canal Zone, and also the cordial assistance of James Zetek, Supervisor of the tropical wild life sanctuary known as Barro Colorado Island, I was able to start at once for the site of Madden Dam. Before leaving for the back country, however, I visited Dr. Herbert C. Clark, Director of the Gorgas Memorial Laboratory, at Ancon. Doctor Clark has been compiling statistics relating to the occurrence of poisonous snakes in the Madden Dam area. The writer was astonished to learn that eleven additional bushmasters had been killed there during a period of eighty-five days. Some of them had been big brutes, about nine feet long, and their fang length was most impressive. The heads ranged from about three inches in length to those of growing examples with head not much larger than a walnut. These observations clearly demonstrated that the bushmaster is of more frequent occurrence in Panama than any other known portion of its range, which appears to extend from southerly Costa Rica to the Matto Grasso in Brazil, and easterly Bolivia.

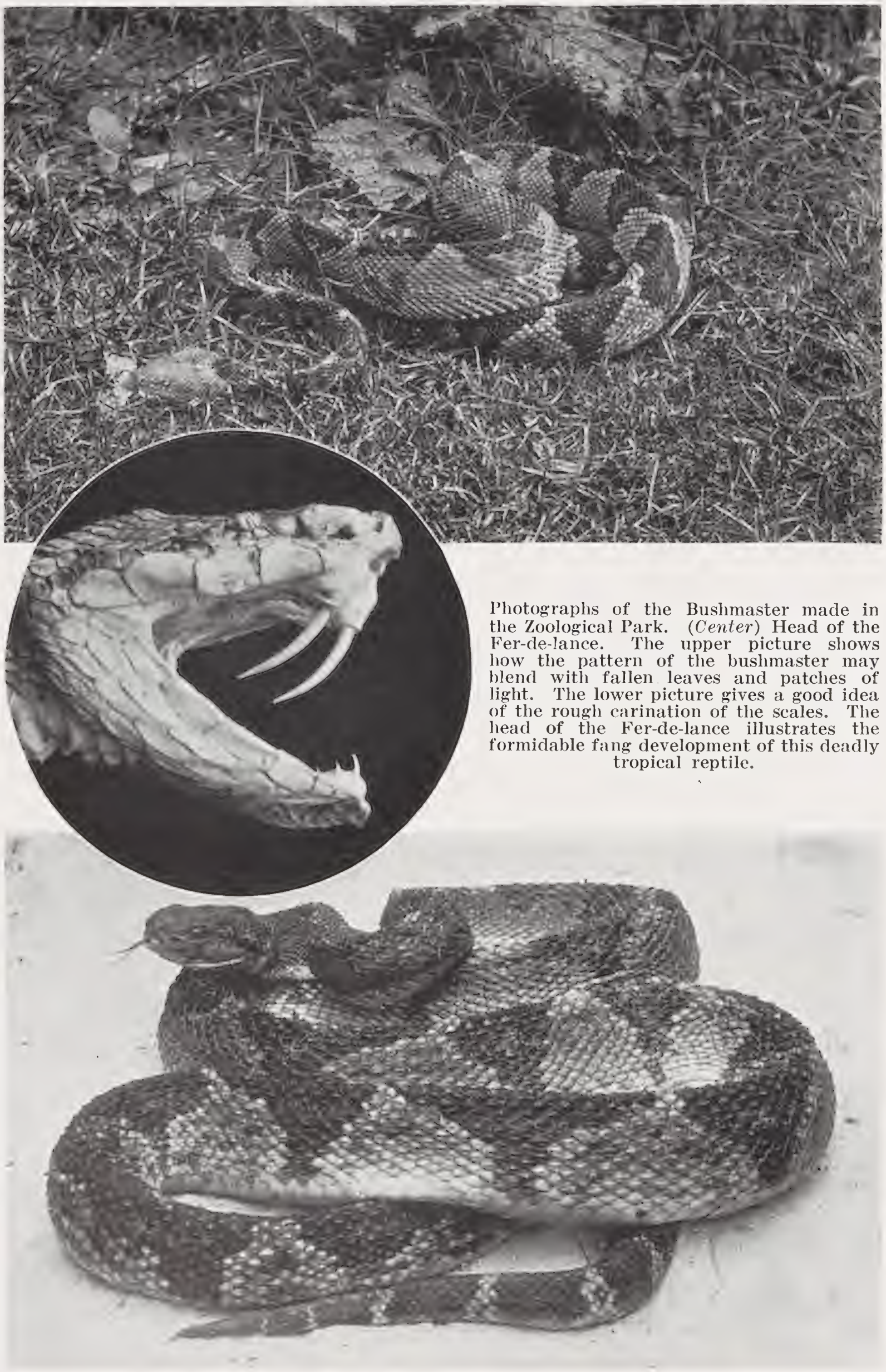
In company with John O'Reilly of New York, and Arthur Greenhall, a student in the University of Michigan, I motored from Ancon and up the cement road to Madden Dam on the evening of September 2nd. It was the height of the rainy season, and a steady shower fell all the way, accompanied by almost incessant lightning. As we left the Canal Zone and entered the road through jungle country, we ran slowly to watch the surface ahead of the car. Boas are often seen crossing this road at night, and several bushmasters have been likewise killed. The rain was apparently too heavy for serpents to be abroad. We saw nothing except frogs and toads, legions of which were squawking, trilling, croaking and chattering in ditches alongside, their songs loudly apparent over the sound of the motor and slosh of tires on the wet surface.

Arriving at the clearing where the engineers' houses are grouped, the area walled in by jungle on all sides, we found everything dark, with everybody in bed — for it seems the working crowd at Madden Dam rises early, or anywhere between three and four o'clock in the morning. A great deal of work is thus accomplished before the steamy heat of midday. We finally located and aroused Mr. Randolph, chief of construction, and were comfortably quartered in a mosquito-screened house on high, stilt-like posts, as all of the engineers' and workers' houses were built.

The nocturnal chorus of amphibian and insect songs was so amazing that we unpacked our flash lamps and turned to investigation and collecting for several hours. The yield that night, as on the several evenings we were there, was highly productive of particularly interesting specimens. We collected a large species of *Leptodactylus,* an extremely decorative frog as large as the bullfrog of the States. Its hues were bronze, red and yellow, but most unique about it was a spur on the inner portion of each forelimb, very effectively used by the creature in grasping one's fingers and inflicting painful wounds. A half dozen species of *Hyla* (large tree frogs) were found. One of these had a vivid green body and a head as blue as if it had been dipped in cobalt. Another species was almost white. Our lights revealed it sitting on broad leaves

The Toucan. The toucan is a rather friendly and fearless dweller of the tropics, and makes his presence known as though aware of the interest that his bizarre form and colors will present to the eyes of the explorer. One of these birds, the Aracari toucan, is perched on the topmost horizontal bough of the tree and the photograph was made at a distance of not more than twenty feet. As he displayed himself, he fed on the fruit clusters of the tree, plucking the seeds from the tips, tossing each one into the air and catching it in his enormous beak.

A tropic jungle. To the layman a tropic jungle is a dream of the garden of Eden. Open glades, beautiful flowers, gorgeous birds and an endless array of delicious fruits. True enough, but unless the bed of a stream can be followed or a trail exists, a tropic jungle is a formidable barrier of close-growing vegetation and a labyrinth of vines, so tightly interwoven as almost to defy penetration. Beneath a canopy of luscious greenery the air is like a super-charged steam kettle and under foot are myriads of rapacious insects that relentlessly defy any invasion of their domain.



Photographs of the Bushmaster made in the Zoological Park. (*Center*) Head of the Fer-de-lance. The upper picture shows how the pattern of the bushmaster may blend with fallen leaves and patches of light. The lower picture gives a good idea of the rough carination of the scales. The head of the Fer-de-lance illustrates the formidable fang development of this deadly tropical reptile.

overhead. Incongruously, for a frog, its *fore-feet* were extensively webbed. All of the toads and frogs had characteristically different songs and we traced them by these sounds, then located their exact situation with our lamps. Greenhall had a jacklamp attached to his head, with battery suspended from his belt. We found this immensely useful. In later experiments, it was found that with such lamps, with diffuse reflectors, one can walk through the jungle trails at night with as much facility as during daylight.

Our search for a bushmaster started the next morning, with Abe Halliday, engineer of sounding projects, as our guide. Mr. Halliday had killed several bushmasters. He took us to the very spots where the serpents had been encountered. Our route followed a narrow trail kept open to inspect borings made by the engineers to determine the stability of the ground at depths of several hundred feet. These borings are in areas extending on each side of the "wings" of the dam. If the Chagres later shows an inclination to seep underground and around the dam, hollow areas, between hidden limestone ledges, will be pumped solid with clay or cement. The impressive variety of flora, the great ceiba trees and pendant lianas, and the narrow trail through an atmosphere like a hot-house, freshly watered, indicated nothing of disturbance to the area, no sign of an engineering project. The only indication of the soundings was an occasional heavy pipe protruding from the ground. All scars of work or excavation had been smothered by rapid jungle growth, which comes with the rainy season.

A unique condition of this jungle was the presence of extensive limestone ledges. They cropped up unexpectedly as we rounded turns in the trail. Between them were stretches of jungle floor, soft and matted disintegrated vegetation and forming the richest type of root-feeding medium. Mr. Halliday explained, however, that underground was a labyrinth of limestone shelves and caves. We found many evidences of this in natural holes, which looked like wells. Some of the surface ledges, running to contours of three hundred feet, or a bit over, looked like the rattlesnake "dens" in New England. They were seamed with fissures and big flat fragments for reptile shelter. Their only difference was in situation. A rattlesnake den would be open to the sun, facing to the south. These ledges were heavily shaded by the tropic forest. Little or no sun ever reached them. An aeroplane reconnoiter over these forests would not have given one the remotest idea of this peculiar, ledgy condition, with its many sheltering crevices—appearing to account for the unusual abundance of the bushmaster.

The bushmaster is thought to represent the ancestral stock whence the rattlesnakes were derived. In form and relationship, it is close to the rattlers. Throughout the rattlesnake genus, there is invariably the tendency, where ledges are present, for these snakes to make such places their home. Thus the bushmaster appears to indicate both parallelism in habits and relationship to the rattlesnakes.

At one spot in particular, where Mr. Halliday had shot a big bushmaster, the association with the presence of the snake and limestone shelter, was clearly evident. The spot was at the base of a giant ceiba, the buttressed roots of which appeared to spread at least twenty feet. This giant base was flattened, in crescentic form. One could stand within the curve and seek shelter under a hollow like a half of an Indian tepee. The bushmaster was seen in the natural clearing near the tree. It immediately showed fight, edged up toward the party, and after sweeping strokes, extended its striking loop for more telling effect. Not ten feet away—in fact, extending nearly to the tree—was the base of an extensive limestone ledge. We investigated this ledge, finding it seamed with great crevices, and finally found a cave which we entered to a depth of fifty feet. Such a ledge in the southerly Berkshires, the Kittatinny Mountains of New Jersey, or along the Delaware in Pennsylvania, would have stopped us short, to look for rattlers. We saw no sign of bushmasters on this ledge, but then again, I have been in spots where I knew there were plenty of rattlers, and day after day have failed to find them. There are days when they are out, and periods when they are not to be found. What the combination is, whether temperature or some other condition of weather, remains a puzzle to the writer. I located no bushmasters in the few days possible to remain among these ledges, but the studies will be resumed the coming summer, with the hope of adding an interesting exhibit to the Park.

The Ceiba tree. The ceiba or silk-cotton tree of tropical America grows to lofty heights and may be commonly seen towering over the surrounding foliage of the jungle, its white trunk appearing like a bar of silver against the green background. These mammoth trees set solidly in the ground and to make their support the more secure their buttressed bases spread out over a diameter of twenty feet or more. In a situation precisely like this, prospecting engineers engaged in the hydraulic improvements of the Panama Canal system, killed a large bushmaster. The thick undergrowth offers a safe and scarcely invaded retreat for these deadly vipers.

General Information

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee of the Society

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

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Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. 21 editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
View of Park: Book; 24 pp. 75 color ills.
Post cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park (*out of print*).
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Pheasants: Their Lives and Homes (Beebe); 2 vols. 4 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
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Cultivation of Fishes (Townsend); 27 pp. 17 ills.
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A

Aberdare mountains, 33
Ailuridae, 127
Alligator, American, 3
Alligator mississippiensis, 5
  Chinese, 20
  food of, 5
  sinensis, 20
Andros Island, 55
  young tarpon on, 65
Angler fishes, 115
Anolis, 57, 59
Antennarius scaber, 115
Antares, on the, to the West Indies, 97
Anthony, Harold E., 85
Antigua, 99, 101
Asterias forreri, 72
  forbessii, 75

B

Babcock, L. L., 66
Bacon-Andros Expeditions, The, 55
Bacon, Daniel, 55, 61, 79
Badger, ratel or honey, 127
Balboa, 110
Barbuda Island, 98, 101
Barrett, Charles, 17
Bathysphere exhibited, 52
Batophora, 61
Beebe, William, 51, 52, 65, 66, 97, 115
Behavior of a pair of leaf-fish, 68
Binturong, 121
Blenny, gattorugine, 76
Bongo, The quest of the, 27
  capturing, method of, 29
  coloring of, 32
  comes to Zoological Park, 33
  foster-mother, 31
  news, bongo snared, 31
  preparing for ocean trip, 33, 34
  trip to Zoological Park, 34
Boocercus eurycerus isaaci, 45
Bowlin, Bert, 64
Breder, C. M., Jr., 55, 65, 79, 80
Bryan's Mrs., aviaries, 110
Bushbucks, 38
Bushmasters, 103
Buzzards, 58, 60

C

Caiman latirostris, 9
  sclerops, 9
  yacare, 9
Canidae, 83
Carapus bermudensis, 79
Carnivores, the smaller, 119
Cayman, black, 9
  Cuvier's smooth-fronted, 9
  Schneider's smooth-fronted, 9
Century Progress Exhibition, 52
  bathysphere exhibition, 52
Chance, Col. Edwin M., 97
Chidester, Prof. F. E., 75
Civits, African, 121
  Indian, 121
  palm, 121
Coates, C. W., 68
Crocodile, American, 5
  Indian mugger or swamp, 17
  rough-backed, 17
  salt-water, 17
  sharp-nosed, West African, 16
  smooth-backed, 18
Crocodilians of the World, 3
  New World, 5
  Old World, 11
Crocodilus acutus, 5
  cataphractus, 16
  niloticus, 11
  novae-guineae, 17
  palustris, 17
  porosus, 17
  siamensis, 17
Cuban crocodile, 5
  capturing, 5, 7
Cuvier's smooth-fronted cayman, 9
Cyclura, 63
Cynodictis, 83, 85
Cyprinodon baconi, 65, 67

D

Daphoenus, 83, 85
Development of the silky marmoset, 175
Devilfish, 111
De Sola, C. Ralph, 3, 5
Ditmars, Raymond L., 3, 38, 119, 175
Dog, Cape, large-eared, 85
  South American bush, 85
Dogs, list of principal types of, 87, 88
Dunton, S. C., 68, 80
Dytiscus, 65

E

Echinoderm enemies of fishes, 72
Echinus miliaris, 76
Eland, 38
Elephant, "Thong Kham", 47
  "Siri Nan", 47
Eleutherodactylus ricordii, 59
Escape, The, 55, 56, 61
Evermann, B. W., 65, 66

F

Field book of Shore Fishes of Bermuda, 51
  describes 335 species, 51
  results of four years work, 51
Fishes, migration of, 115
Flying-fish, 102
Forsyth, E. W., 58, 67
Frog, tree, 57
Fundulus, 76

G

Gambusia, 67
Gavial, Indian, 17
  Malayan, 20
Gavialis gangeticus, 17
Genets, 121
Gobius paganellus, 76
Goby, common, 76
Gregory, W. K., 52, 83
Grenadines, 98
Griem, Carl, 67
Gudger, E. W., 72

H

Harnessed antelopes and their allies, the, 38
  related species, 45
  subfamily Tragelaphinae, 45
Hepburn, Jackson, 56, 61
Hollister, Gloria E., 97
Holothurian, 79
Huntington, L. D., 56
Hyaenarctos, 85
Hyla, 57
  septentrionalis, 59

I

Icticyon venaticus, 85
Iguana, Andros, 63
Illustrated London News, 27
Ingram, Bruce S., 27

J

Jacare-assu, Caiman niger, 9
Jennings, Prof. H. S., 72
Johnson, Margaret S., 26

K

Kenya Colony, 27
Kingston, Jamaica, 103
Kudu, greater, 38

L

Labrus mixtus, 76
Lake Forsyth, 58
Lang, Herbert, 16
Leaf-fish, behavior of a pair, 68
  spawning, 69, 71
Leiocephalus, 59
Leister, Claude W., 33
Lemming, 143
Leontocebus rosalia, 175
List of principal types of dogs, 87, 88
Lizards, small, 57
Lobster burial, A, 80
Loveridge, Arthur, 16
Lutianus griseus, 57

M

Mangrove Cay, 64, 65
Marmoset, silky, 175
  birth of twins, 175
  feeding habits, 176
  raising their young, 176
Marsh, M. C., 65, 66
Martinique, 99
Matthew, W. D., 83
McDaniel, Edwin B., 47
Migration of fishes, 115
Milk River, 58
Milligan, H. N., 74
Miner, R. W., 55
Miocene dogs, 85
Mongoose, Indian, 121
Monocirrhus polyacanthus, 68
Muridae, 143
Mustelidae, 119
Mustelines, 121

N

Nature's wild dog show, 83
New World crocodilians, 5
Nile crocodile, 11
Nyala, 45

O

Old World crocodilians, 11
Osborn, Henry Fairfield, 17
Osteoblepharon osborni, 17
Osteolaemus tetraspis, 17
Otocyon megalotis, 85
Otter, 121

P

Pachyderms, royal, in Siam, 47
Paleosuchus palepebrosus, 9
  trigonatus, 9
Panama, 110
Panda, 127
Pantodon buchholzi, Contents page, No. 3
Parker, Prof. G. H., 77
Pearl fish from Nassau, A, 79
Pearl Island, 110
Percy-Smith, Col. E., 27, 33
  expedition to Aberdare Mountains, 27
Physo, 61
Plaice, 76
Pleuronectes platessa, 76
Pluvianus aegyptius, 11
Procyonidae, 127
Puffer, West Indian, 57
Putnam's Sons, G. P., 52

Q

Quest of the bongo, The, 27

R

River Lees, 57
Rodentia, 143
Rodents or gnawing animals, 143
Roule, Louis, 115

S

Saba Island, 98, 101
Saboga Island, 110
Sanborn, Elwin R., 143
Schmidt, Karl Patterson, 17
Sea-cucumber, 79
Sea urchins feeding on fishes, 76
Sherwood, George H., 52
Siphonostoma typhle, 74
"Siri Nan", elephant, 47
  pinned beneath muddy watter, 49
Smaller carnivores, 119
Snapper, gray, 57
Starfishes and sea urchins catch and eat fish, How, 72
  attacking fishes, 72
  pipefish, 75
  food, 72, 74

T

Tarpon, young, on Andros Island, 65
Tee-Van, John, 51
Temnoeyon, 85
Tetraodon testudineus, 57

Thalassoma duperrey, 111
"Thong Kham", elephant, 50
poisoned with strychnine, 50
Tobago Keys, 98
Tomistoma schlegeli, 20
Tragedy among royal pachyderms in Siam, 47

A

Agouti, golden, 172
Alarodia slossoniae Packard, 63
Algae in fresh-water lake, 59
in aquarium with fishes, 59
Alligator pool in Zoological Park, 1
Alligators, American, in Reptile House, 2, 10
American, skull, 24
lateral view of jaw, 24
lower jaw, 24
and crocodiles in Florida, American, 12, 13
Chinese, 22
eggs, 8 c
Anchovies, school of (drawing), 114
Andros Island, chart, 56
lizard, 57
tree frog, 57
Andros Cove, fresh water suds, 60
Anglerfish, spotted, 112
attracting its prey, 113
with all fins spread, 113
Antares at sea, 97
cruises of the, (Map), 98

B

Bacon, Daniel, exploring South Andros, 54
Badger, American, 118, 133
ratel honey, 132
Barbuda Island, showing Martello Tower, 102
village of, groups of conical thatched huts, 103
Barracuda, 78
Bassariscus astutus, 137
Beaver, 158
alarmed, diving, 159
coming out of pond, 159
dragging small timbers into dam, 159
feeding, 160
filled sluiceway in dam, 159
feeding,
idly floating, 159
resting, 161
Binturong or bear cat, 123
head, 123
Bongo, characteristic attitude, 36
detail of thick ridge of hair along spine, 31
head of, Cover, No. 2
head, mounted, Zoological Park, 29
showing large ears, 33
mounted specimen in England, 29
painting by Margaret S. Johnson, 26
portraits of head, 37
showing curiously striped markings, 72
stripes on left side, 34
on right side, 34
suckled by cow, 30
unsymmetrical arrangement of stripes, 37
young female captured in forest of Kenya, 28
Boselaphus tragoeamelus, 44

C

Camp on shore of Lake Forsyth, 62
Cape hunting dog, head, 82
Capybara, 174
Cavy, 171
Cayman, broad-snouted, 16
black, 15
Central American, 14
Cuvier's smooth-fronted, 16
Paraguayan, 16
Schneider's smooth-fronted, 16
spectacled, 15
South American, 16
Chart of Andros Island, 56
Chipmunk, 150, 151
Civit, American (head), 118
African, 122
Indian, 120
Coati mundi, 138
head, 118
ring-tailed, 138
Coyote, 82, 91
Tragelaphus scipttus scriptus, 38
angasi, 45

U

Union Island, 98
Urchins, purple-tipped, 76

V

Viverridae, 119

ILLUSTRATIONS

Crocodile, American, 10
American, jaw, 24
lower jaw, 24
skull, 24
and alligators in Florida, 12, 13
Australian, 23
Central American, 14
Cuban, 11
fossil, (drawing), 4
from European rocks, 4
Nile, 18
Orinoco, 14
rough-backed, 19
salt water, 23
Siamese, 21
smooth-backed, 19
West African, 18
Crocodilian distribution, (map), 6
respiration, 8

D

Devilfish swimming below the surface, 110
rising and swimming near the surface, 111
Dingo, 82, 89
Distribution of Bongo (map), 35
Dog, bush, 96
cape hunting, 96
head, 82
crab-eating, 95
eskimo, 89
head, 82
evolution of upper teeth, leading to the true dog, 87
fossil, giant (head), 86
Japanese and Chinese racoon, 92
small-eared, 95
Dolphins, swimming under bow of Antares, 108
crossing bow of Antares, 109

E

Eland, male, 42
female, without stripes, 43
striped female, 43
Elephant, head, in Zoological Park, 47
in Zoological Park, 50
"Siri Nan", 47
"Thong Kham", 49
Elephants employed to capture "Siri Nan", 46
Eskimo dog, (head), 82
Exploring Tobago Keys in Grenadines, 99

F

Ferret, American black-footed (head), 118
black-footed, 127, 129
Fisher, 126
Fishes, new from Lake Forsyth, 62
Flying fish, Cover No. 3
black butterfly, (wings), 106
reddish-winged, 107
wings, of, 107
short-barbelled, (wings), 106
two-winged, (wings), 106
Fox, Arctic, 94
gray, 93
red, 93
head, 82
swift or kit, 94
Fresh water suds, Andros Cove, 60
Frog, tree, 57

G

Gambusia manni, 57
Garvial, Indian, 21
skull, 24
jaw, 24
Malayan, Cover, No. 1, 22

H

Hare, 175
jumping or African spring-hare, 164
Hutia, 170
Hyla septentrionalis, 57

W

Walling's Island, 103
West Indies, to the, On the Antares, 97
Wild dog show, nature's, 83
Wolverine, 127
Wrasse, striped, 76

J

Jackal, head, 82
black-backed, 90
Indian, 90
Jerboas, 163

K

Kinkajou, 139
Kudu greater, 39
adult female, showing opposite sides, 40
mother and young, 41

L

Landscape near Grassy Creek, 60
Leaf-fish returning to eggs, 68
a pair of eggs, 70
with mouth open, 69
Leeward Islands, 100
Leiocephalus carinatus, 57
Lepus californicus texianus, 175
Lizard, Andros Island, 57
curly-tailed, 57
Lobsters, shedding shell, 80

M

Mangroves, stunted and tempest-torn, 63
roots, exposing dried marl, 63
Map of Africa, showing distribution of Bongo, 35
Martinique, Island of, 100
Meerkat, 124
Mice, cheek-pouch or pocket, 162
Milk River, 59
Mink, American, 129
Moth, white, the purpae, 63
Motor car destroyed by elephant, 63
Muskrat, 161

N

Negro village of Deep Creek, 64
Nylghai, adult male, 44
female, adult, 45

O

Osteology of the principle crocodilians, 24
Otter, Canadian, 134
Oysters clinging to mangrove branch, 105

P

Paca or cavy, 171
Panda, Cover No. 5, 140
Pantodon buchholzi, 53, Cover No. 3
Pearl fish, side and top view, 79
Porcupine, baby, 167
Brazilian tree, Cover No. 6, 169
Canadian, 166
albino, 167
crestless, 165
hairy tree, 169
yellow-haired, 168
Prairie dog, 153, 154

R

Raccoon, 118
crab-eating, 135
Eastern, 136
albino, 136
Rat, Branick, 171
coypu, 170
tree, 170
Red fox, (head), 82
Resident of South Andros, and dog, 64
Ring-tailed cat, 137
Russian wolf-hound, skeleton, 84

S

Saba, volcanic peak, 104
Sea-urchins, devouring a Fundulus, 76
Seining for tarpon on Mangrove Bay, 66
Sewellel, 157
"Siri Nan", mad elephant, 47
head in water, unable to move, 48
in position which led to untimely death, 48

Skunks, common, 131
Spermophile, 153
Spider lily, 105
Sponger on way to Andros sponge banks, 64
Squirrel, albino, 147
  fox, 148
  flying, 144
  gray, 145, 146, 147
  Malabar, 149
Starfish, after mutual settlement, 76
  another specimen holding great pipefish, 75
  beginning to ingest living fish, 73
  disputing with asteroid for possession of prey, 76
  holding living fish, 72
  holding pipefish, in changed position, 74
  showing partly ingested fish, 73
  supporting itself by arms, holding pipefish, 74
  itself while feeding on fish, 75
Strepsiceros strepsiceros, 39, 40, 41
Suds, meringue like, on lee shores, 60

T

Taurotragus oryx, 42, 43
Teeth, evolution of, leading to the true dog, 87
"Thong Kham", elephant, in front of corral, 49
  motor car, destroyed by, 49
Tree cutting by American beaver, 142
Tropical forest, Pacheca in Pearl Islands, 116

V

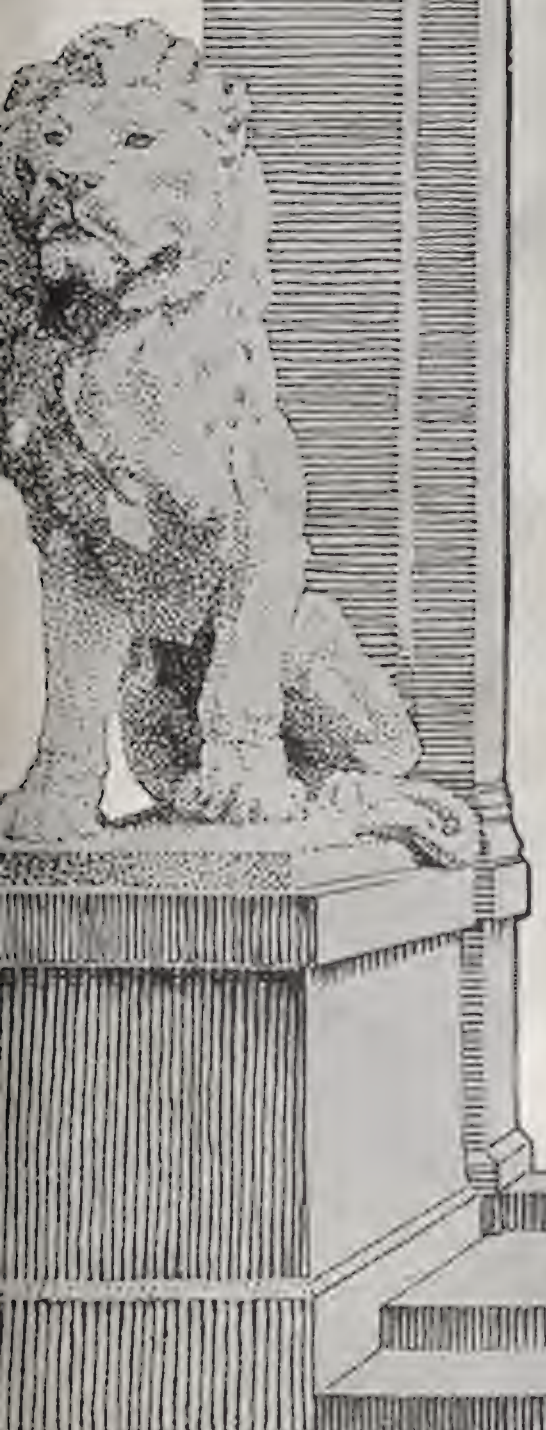
Village of Bottom, 104
Viscacha, 173

W

Weasel, Eastern, 128
Wolf, timber, Cover No. 4, 92
  pups, in Zoological Park, 88
Wolf-hound, Russian, (skeleton), 84
Wolverine, 130
Woodchuck, 155
  albino, 156

VOL. XXXVI, No. 1 January-February, 1933

BULLETIN
NEW YORK ZOOLOGICAL SOCIETY



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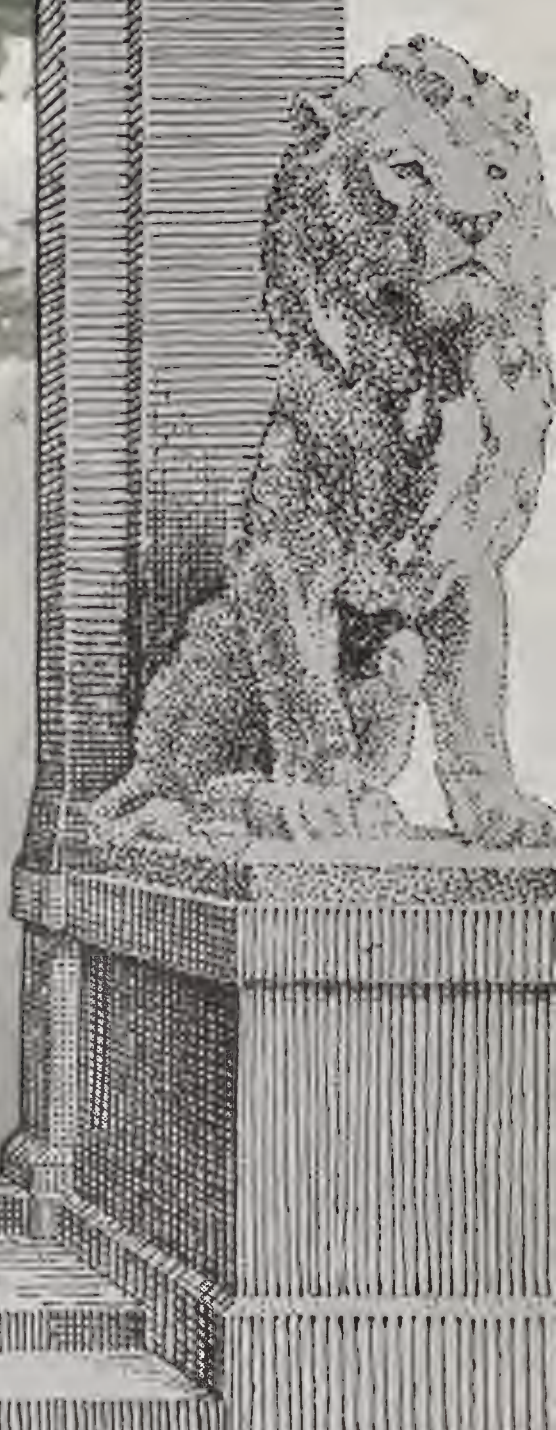

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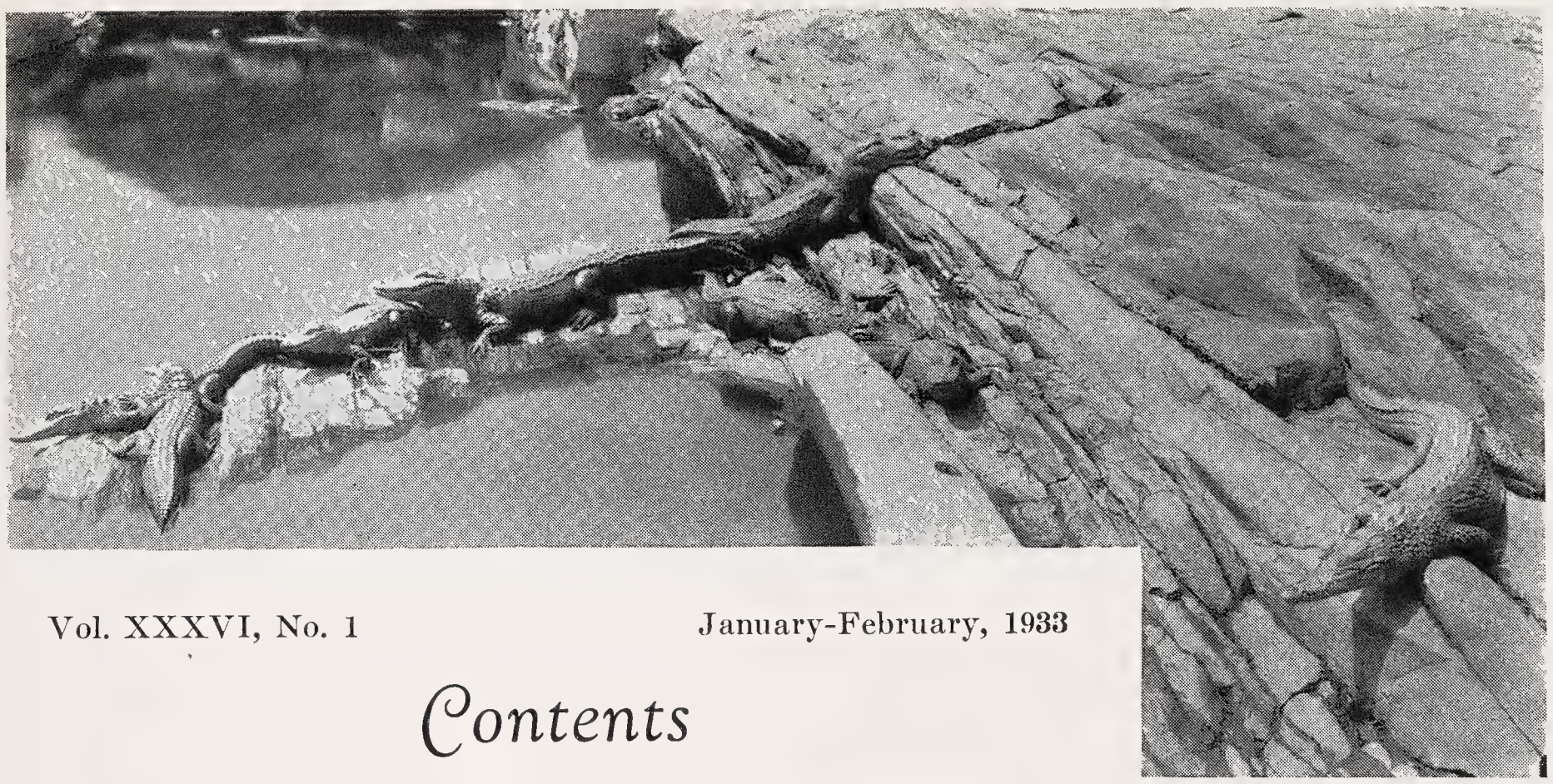

Vol. XXXVI, No. 1 January-February, 1933

Contents

AMERICAN ALLIGATORS, REPTILE HOUSE ZOOLOGICAL PARK ..... *Frontispiece*
THE CROCODILIANS OF THE WORLD ..... *C. Ralph De Sola* 3
FOREWORD ..... *Raymond L. Ditmars*

Illustrations of Species

American Alligator
American Crocodile
Cuban Crocodile
Central American Crocodile
Orinoco Crocodile
Central American Cayman
Spectacled Cayman
Black Cayman
Broad-snouted Cayman
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Smooth-backed Crocodile
Indian Gavial
Mugger Crocodile
Siamese Crocodile
Malayan Gavial
Chinese Alligator
Salt-water Crocodile
Australian Crocodile

Alligator Pool in Zoological Park ..... *Contents Page*
Fossil *Mystriosuchus* 4
Fossil *Geosaurus* 4
Map of Distribution 6
Crocodilian Respiration 8
Alligator Eggs 8
American Alligators and Crocodiles in Florida 12
Osteology of Crocodilians 24
Malayan Gavial, Zoological Park ..... *Cover*

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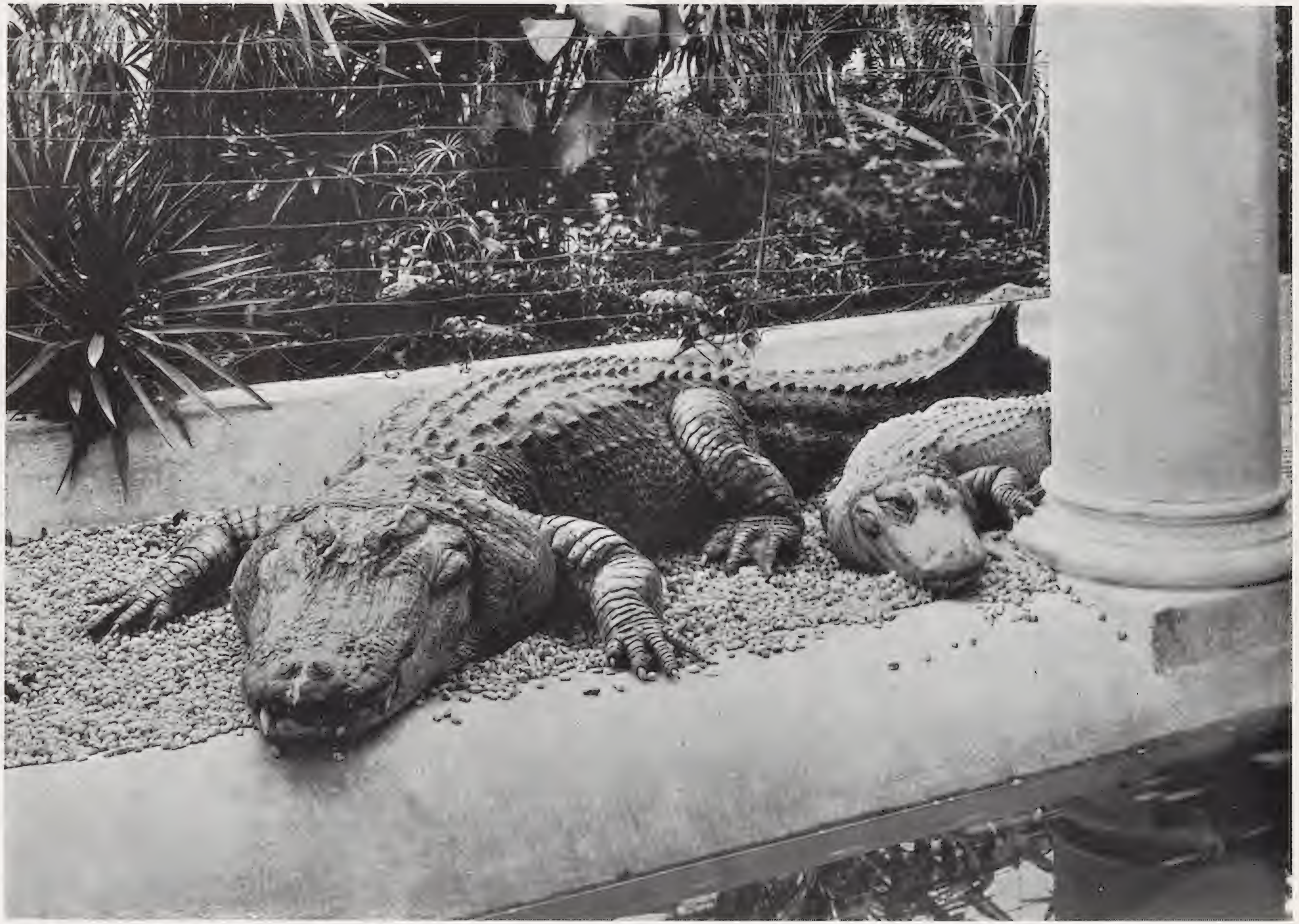

American alligators in the Reptile House in the Zoo'ogical Park. The alligator pool of the Reptile House is a constant source of attraction to visitors. Cypress logs, spanish moss, and a background of tropical vegetation provide a realistic setting.

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The Crocodilians of the World

The Alligators, Caymans, Crocodiles and Gavials of today, by C. RALPH DE SOLA, with a Foreword to the paper by RAYMOND L. DITMARS, Curator of Mammals and Reptiles, Zoological Park

The illustrations in this article are from photographs in the collections of the New York Zoological Society, and unless otherwise noted, many of these are studies of living crocodilians taken in the New York Zoological Park and the New York Aquarium

Foreword

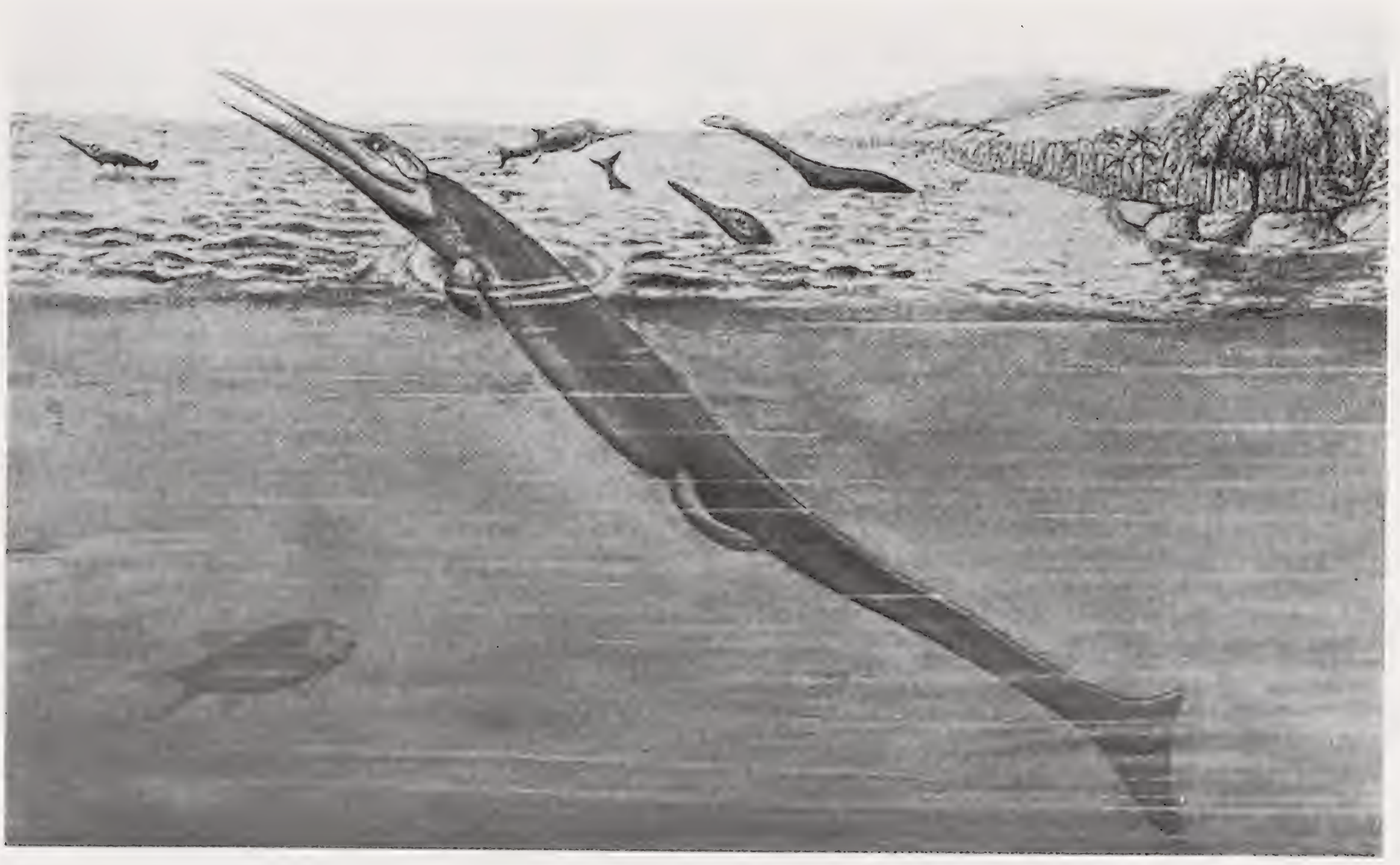
WHILE the crocodilians are by far the smallest order of the reptiles in regard to the number of species, there being, in fact, less than twenty-five different kinds, they form the most impressive grouping. In their massive proportions, they far exceed average weights and lengths of the Chelonians (turtles and tortoises), with over two hundred kinds, both land and marine, and the average from among the larger members of the great order of scaled reptiles, with nearly five thousand species of lizards and snakes.

From numerous fossil remains in Europe and North America, it is indicated that crocodiles, caimans and alligators formerly existed in a much greater variety of species than at the present, but that their size did not much exceed that of the surviving kinds. This condition renders the group particularly interesting, in pointing to the crocodilians being the most ancient types of existing reptiles, surviving remnants of life from past ages, carrying through an illustration of the size and curiously plated forms of remote times.

In the reptile collections of the Zoological Park, crocodilians have always formed an important part, both from the standpoint of exhibition value and of scientific study. With carefully designed, heated tanks, of commodious proportions, in which we have figured that conditions closely approach the natural environment of these creatures, we have made numerous studies concerning their growth. It has been determined that they grow faster than previously alleged, and that maturity may be reached within a period of ten years, although they continue to grow slowly after attaining a breeding age. It is probable, however, that crocodilians attain the greatest age of any living creatures of the world, surpassing the ages of tortoises, which, by recent observations, develop much faster than crocodilians.

The longest record of any specimen in the Zoological Park collections is that of an American alligator, which is still living, and was acquired by the writer approximately forty years ago. Two alligators, continuing to thrive in the Park collection, were hatched in the Reptile House from eggs brought from South Carolina in October, 1900. These three record specimens are slightly in excess of seven feet in length, and may never attain additional length, as all came from an area where impressive dimensions of alligators are seldom recorded. Truly large alligators, twelve feet and over, were well beyond the average, even many years ago when alligators were

Fossil Crocodile *Mystriosuchus*. The crocodilians of the Lower Jurassic period in the great Reptilian age, the Mesozoic, were well armored, related to the dinosaurs, and somewhat resembled our contemporary gavials in appearance. A specimen of this species exhibited in the British Museum shows quartz pebbles in the stomach-contents which are stained black with the sepia ink of cuttlefishes it devoured. This restoration was drawn by the late Dr. S. W. Williston and is reproduced from his "Water Reptiles of the Past and Present".



Fossil Crocodile *Geosaurus*. The adaptation of a crocodile for marine life is depicted in this crocodile taken from the European rocks of the Upper Jurassic. *Williston after Fraas.*

numerous in southern rivers. This American species is considerably surpassed in size by the average dimensions of crocodiles.

The following article has been prepared by Mr. C. Ralph De Sola, and is the result of an examination of a considerable number of scientific articles and papers relating to crocodilians, checking changes in taxonomy, hence the presentation of a modern *resumé* of the group, in readable terms. The article also serves as a vehicle for the presentation of a valuable series of photographs of the crocodilians.

Introduction

THE very remote ages of geologic antiquity witnessed the appearance of the crocodilians. It is believed that this group of present day reptiles has sprung from the dinosaurs and their congeners the geosaurs. They are comparable to these fossil orders in both size and strength. They are the largest of living reptiles as to proportions of bulk and length, one species attaining a length of approximately thirty feet.

Less than a hundred years ago travelers and scientists of reputed veracity testified to the wonderful abundance of the order throughout the tropical world. Today every swamp and marsh, river and estuary, pond and lake of the tropical latitudes gives its toll of these reptiles to hunters.

Regarding their ferocity and danger to man it may be broadly stated that while their predatory instincts are strongly developed, many species are timid and flee at the approach of man. Unless cornered or captured during a hunt these reptiles are most wary and make every effort to escape from the vicinity of the hunter. Crocodiles, however, show a distinctly fierce and sulky temper as compared to alligators. In many localities of Africa and Asia it seems that certain old and wily individuals turn into man-eaters in much the manner of tigers and lions.

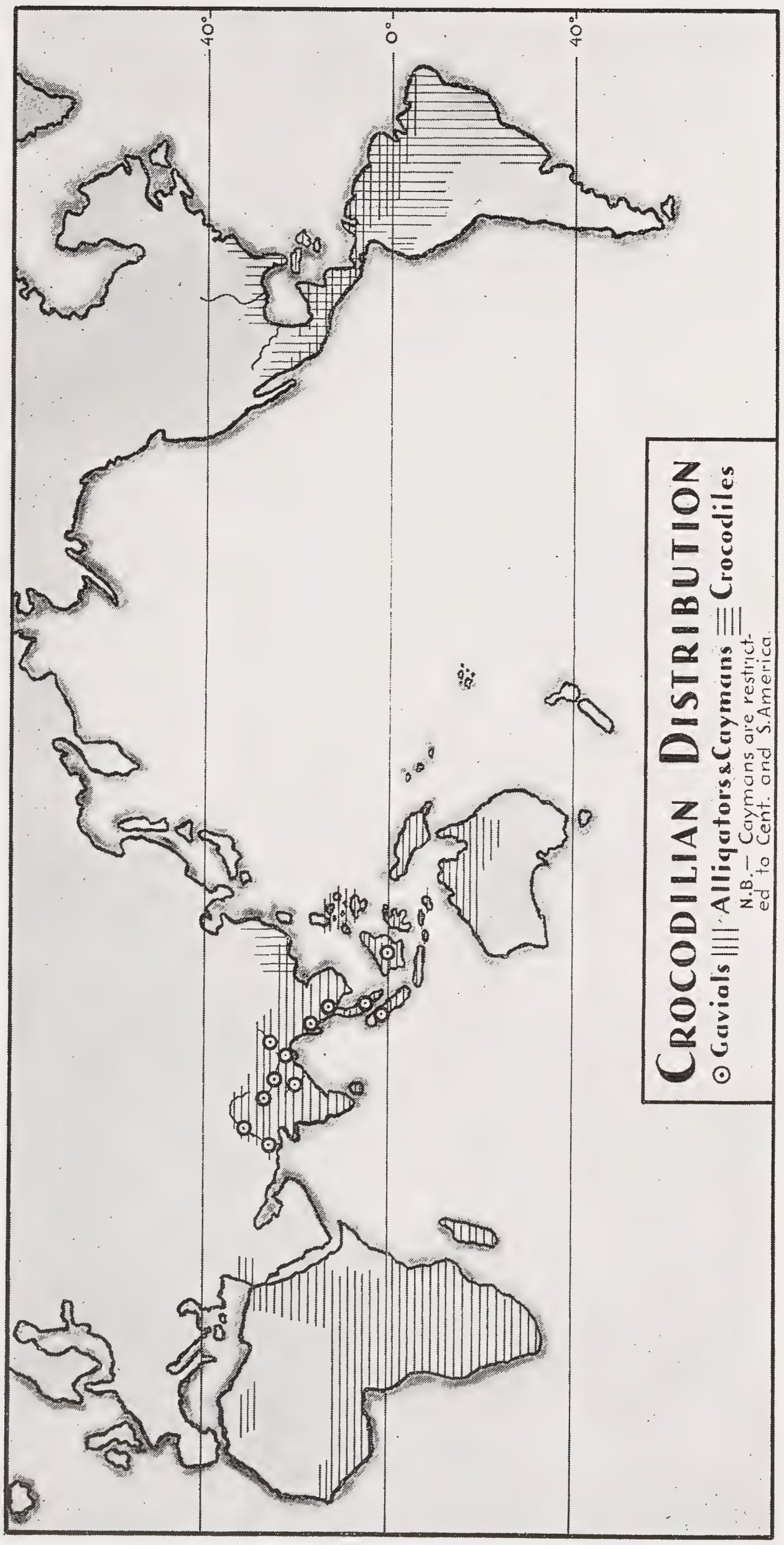
New World Crocodilians

Perhaps the most valuable member of the reptilian fauna of the United States is the American alligator, *Alligator mississippiensis*. It is not surprising that the early Spanish *conquistadores,* filled with mythological lore of dragons and lizards, mistook it for a great lizard and in this connection it is interesting to note that the name "alligator" is a corruption of the Spanish word for lizard—*el largato.* The name "alligator" is used indiscriminately in many parts of the world to denote a crocodile, particularly in Australia. In some of the coastal parishes of Louisiana the outlawing and killing of these harmless creatures has resulted in their near decimation and both Florida and Louisiana have found it necessary to pass conservation laws to restrict the hunting seasons and protect the eggs. The food of the alligator is diversified, consisting for the most part of crustaceans, but fish, turtles, birds or small mammals are a welcome change of diet, as well as insects, these last forming about twenty-five per cent of the food of young individuals.

The American crocodile, *Crocodilus acutus,* has a range more extensive than any of the New World crocodilians. Habitat records and personal observations show that it is found in southerly Florida, throughout the Greater Antilles, except Puerto Rico, and is known from both coasts of Central America where it ranges from Mexico into northern South America. In Cuba the *caiman,* as it is locally known, is actively pursued for its valuable hide and this practice has rendered the animal almost extinct in that Island, as well as in Haiti and in Jamaica, where it has retreated to the northern and eastern coasts, especially near the mouths of the Milk and Black Rivers.

Prior to my expedition to Cuba in 1929, the New York Zoological Society lacked an example of the Cuban Crocodile in their collection of live reptiles at Bronx Park. The notes contained in the field log book of this trip follow with an account of the capture and transportation of the crocodiles obtained from El Tesoro, a freshwater lagoon in the heart of the Zapata Swamp of southern Cuba.

"Cienaga de Zapata, April 20: Near the open part of the lagoon we caught five small crocodiles in an eroded limestone stream bed. Up on a mud flat and near the sluggish water, our quarry were sleeping and we had quickly secured them in a



Map of Distribution. It will be seen that crocodilians never are found in latitudes exceeding the fortieth parallel, this being their northerly and southerly limit and that almost all tropical countries claim one or more species of crocodilians in their faunas. Map prepared by the author.

burlap bag before biting could begin. Went out into the lagoon in a small boat of native manufacture, a *chalana.* The lagoon is a tremendous lake with many inlets that branch into the swampy reed beds. These are not more than four feet wide. The noon temperature was 101 degrees F., and the water registered 81 degrees on the same scale. Hot strong glare and little shade is encountered in the great vista of tall and sharp swamp grass. Many small birds are aloft and seem to chirp a noise not unlike the accentuation of, *cocodrilo, cocodrilo,* a pause and then again, *cocodrilo, cocodrilo.* (*Cocodrilo,* strangely enough, is the local name for this species, *C. rhombifer.*) We burned the reed beds of the lagoon so as to drive out our quarry. Later in the morning at a nearby inlet we walked into the still and muddy water up to our waists. We saw a movement ahead of us and almost instantaneously saw a large crocodile slide and crawl from its sunny reed couch and disappear into the deep channel of water. We followed close and I cast my lasso that was affixed to the end of a four-foot pole over its gaping jaws. My helpers secured its fast-swinging tail and with a lot of struggling we landed our catch in the reed beds. Here we tied the limbs and jaws fast and slinging the crocodile to a pole made off for camp. Arrived at the camp about 4 P.M. and hired some charcoal burners to transport the specimens to the nearest railroad station. Our route was over a single track road and our means a hand car. A steady push of thirty miles got us into Jaguey. Here I placed my specimens in my hotel room and retired. The night was not very restful, as I was frequently disturbed by the struggles of the big crocodile which was constantly getting loose. I finally lashed her to my bedstead and slept until dawn. April 21: Found the local carpenter and built two crates. Accompanied them on the Havana train and wired to Dr. Blair to notify him of their projected arrival on the *Toloa.*"

For many years the Central American crocodile, *Crocodilus moreletii,* had been cast in the synonomy of the Cuban crocodile, *C. rhombifer,* when Dr. K. P. Schmidt of the Field Museum, rediscovered it. In the Sibun Swamp, near Belize, British Honduras, it is found on the shores of the lakes and irrigation ditches that fill it. In skull and body outline the Central American crocodile is strongly suggestive of its Cuban ally and only very slight cranial differences serve to distinguish them. Little is known concerning the range of this crocodile, although Schmidt gives it as being from "Tampico to Belize." Possibly it is restricted in much the manner of the Cuban crocodile and will eventually disappear under the machete and gun of hide hunters.

The crocodile of the Orinoco, *Crocodilus intermedius,* is noted for its ferocity and great length. Baron von Humboldt in 1800, reported seeing specimens of twenty-five feet. However, a recent expedition of the National Geographic Society to this region records finding nothing over ten feet in length and strongly discredits Humboldt's observations as being the result of his helper's imaginations. This crocodile is endemic to the entire area of the Orinoco delta and the adjacent Guianas. It does considerable damage to the natives who retaliate by destroying its nests. Its presence has a decided effect on convicts quartered in the bush of French Guiana whose attempts at freedom are inhibited or suddenly frustrated by the dreaded man-eater. Death from this crocodile is indeed terrible:—a side-swipe of the powerful tail, a crackling report of closing jaws, a few bubbles rising from the river bottom—the prey is finished. The body is dragged off to some submerged hole and the reptile returns to eat it when decomposition has set in. Over 200,000 skins of this species and its neighbors, the caymans, were exported during 1930 and still the crocodilians remain in sufficient numbers to menace the local population.

The seven crocodilian species of caymans live in the great, warm pools formed principally by the Magdalena River of Colombia, the Orinoco of Venezuela, the Amazon and its tributaries in northern South America, and the Plate of the Argentine. Flowing through tangled, tropical vegetation for thousands of miles, eddying and swirling past fallen trunks, lazily lapping the sandy mud-flats of their mouths, these fluvial waters provide the natural habitat for the alligator-like caymans, spectacled caymans, smooth-fronted caymans, the former with horny ridges around the eyes, the latter less professorial in appearance. The spectacled type is distinguishable from all other crocodilians by the presence of a transverse, bony ridge between its eys. Both

Crocodilian Respiration. The most remarkable feature in the physiology of crocodilians is their manner of breathing when eating under water or partly submerged. Skull examination reveals that their posterior nostrils are set so far back in the head and are so well separated from the cavity of the mouth by a bony palate that it is impossible for water to enter their breathing passage. Two valves at the back and sides of the mouth prevent water from running down their throat into the gullet. A study of the circulatory system reveals the highest state of development found among reptiles. The heart is four chambered and supplies blood to the head, trunk, and tail through an aorta in much the manner of higher vertebrates. Photograph by Raymond L. Ditmars.

Alligator Eggs. Crocodilians lay hard white eggs about two and one-half inches long by one and three-quarter inches in diameter. In most cases the nest is prepared during the day by heaping together masses of dead vegetation and placing a hollow in the center. The eggs are laid in this and carefully covered with earth and twigs making a hard compact mass. The sun's heat plus the moisture generated inside the nest by the decaying vegetation incubates the eggs in about nine weeks. In some dry sandy localities the eggs are laid in holes during the wet season. Photograph by Raymond L. Ditmars.

types are abundant and cover vast geographical divisions of the southern continent.

Through southern Mexico, the Central American republics and eastern Colombia ranges the smallest present-day crocodilian known to man. This four-foot loricate is the Central American cayman, *Caiman fuscus,* the species so often seen by travelers passing through the Panama Canal. Here the wake of the passing steamer stirs the shore line, a muddy shore line with occasional log-like objects breaking its monotony. With the wake, metamorphosis takes place—the log becomes a reptile and the reptile turns for the deep turbid waters of the Isthmus. Some hundreds of miles southward we find the cayman in the Magdalena. The river indians of Colombia's great stream call it *babilla* and while they do not fear it their capture of it seems courageous. Lashing two pointed stakes crosswise and attaching a raw-hide rope to the intersection, they coil its free end about their waist and stalk through the reed beds, half-submerging themselves below the river bank. In one hand they hold the outthrust stakes while the other hand quietly slaps the water in a manner calculated to imitate a domestic animal's drinking. Thus they await their prey. Several hours' patience brings its reward — a hungry *babilla,* over-anxious to gorge. Rushing to the point of the sound, tail lashing, jaws agape, the cayman closes on the extended arm. The stakes are firmly implanted and wedged in its oral cavity, the indian is up the bank, and tugging. A stroke of the machete and another valuable hide is made ready for export. This is rubbed with salt on the flesh side while the tail is carried home to the al fresco kitchen and provides a delicacy.

The dark-olive, brown-skinned cayman of northern South America, *Caiman sclerops,* the spectacled cayman, ranges from Eastern Panama to northern Brazil where it is spoken of as *jacare-tinga.* The pronounced, horny protuberances about its eyes give it its name.

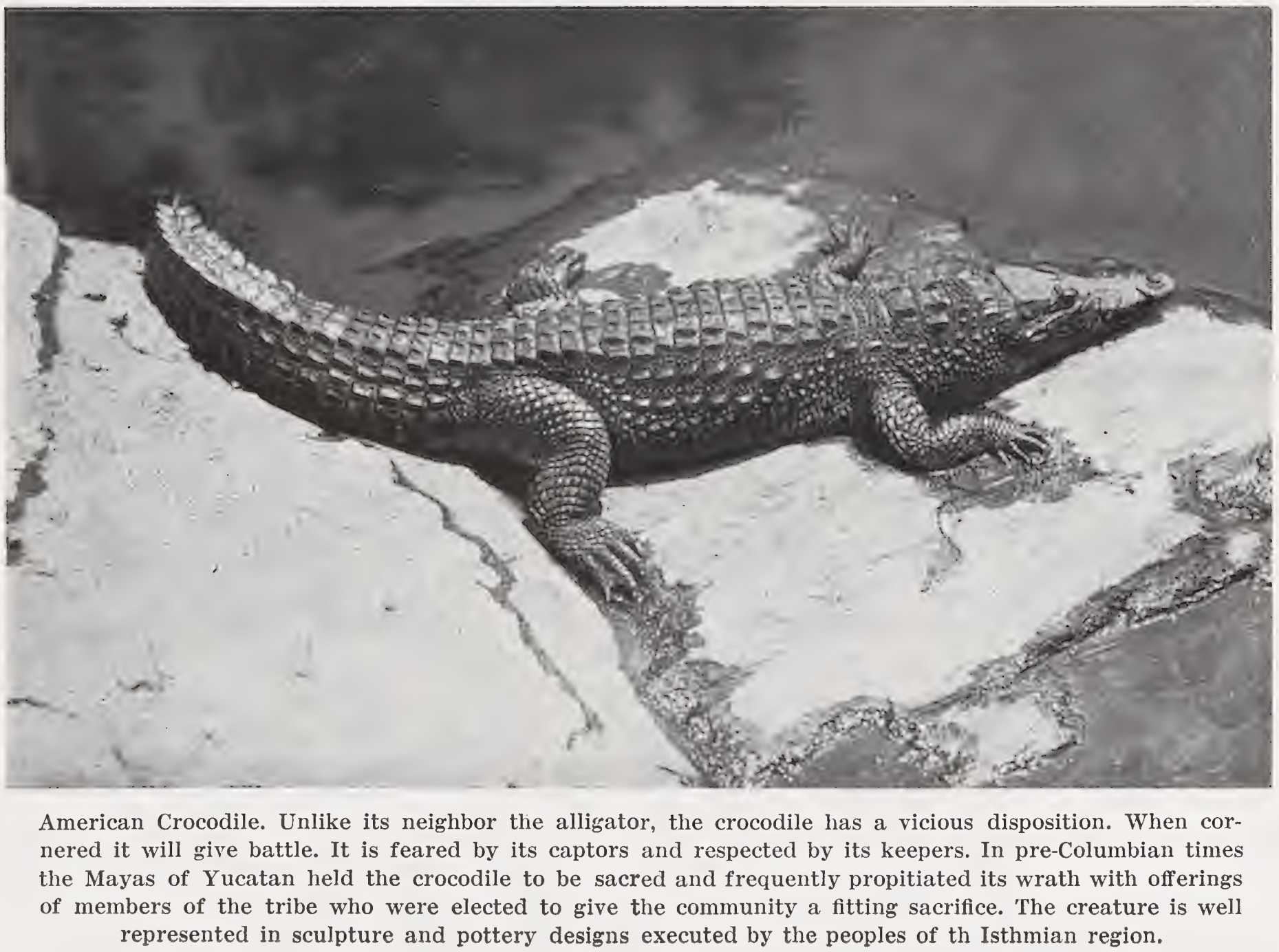
The young of most crocodilians are hard to tell apart; however, the juvenile representatives of this species are of a golden-brown body color, speckled with black, the underparts being muddy colored.

The largest and most powerful representative of the caymans is the *jacare-assu, Caiman niger,* of the Amazon Basin. The body is evenly scaled, black colored above and yellow beneath; the coloration of the body and the distinct, alligator-like skull, at once distinguish the Black cayman from all others. Occurring in the heart of the little known and unexplored interior of Amazonica the Black cayman is feared by the natives who are ever ready to tell tall tales concerning its size, prowess, boldness, and voraciousness. The females lay from thirty to forty eggs in a hole which they form with leaves, river slime, and the reeds of the river shore. The food of the species consists of fish, of which there are many in the Amazon, large river turtles, and mammals which are seized when they come down to the water to drink.

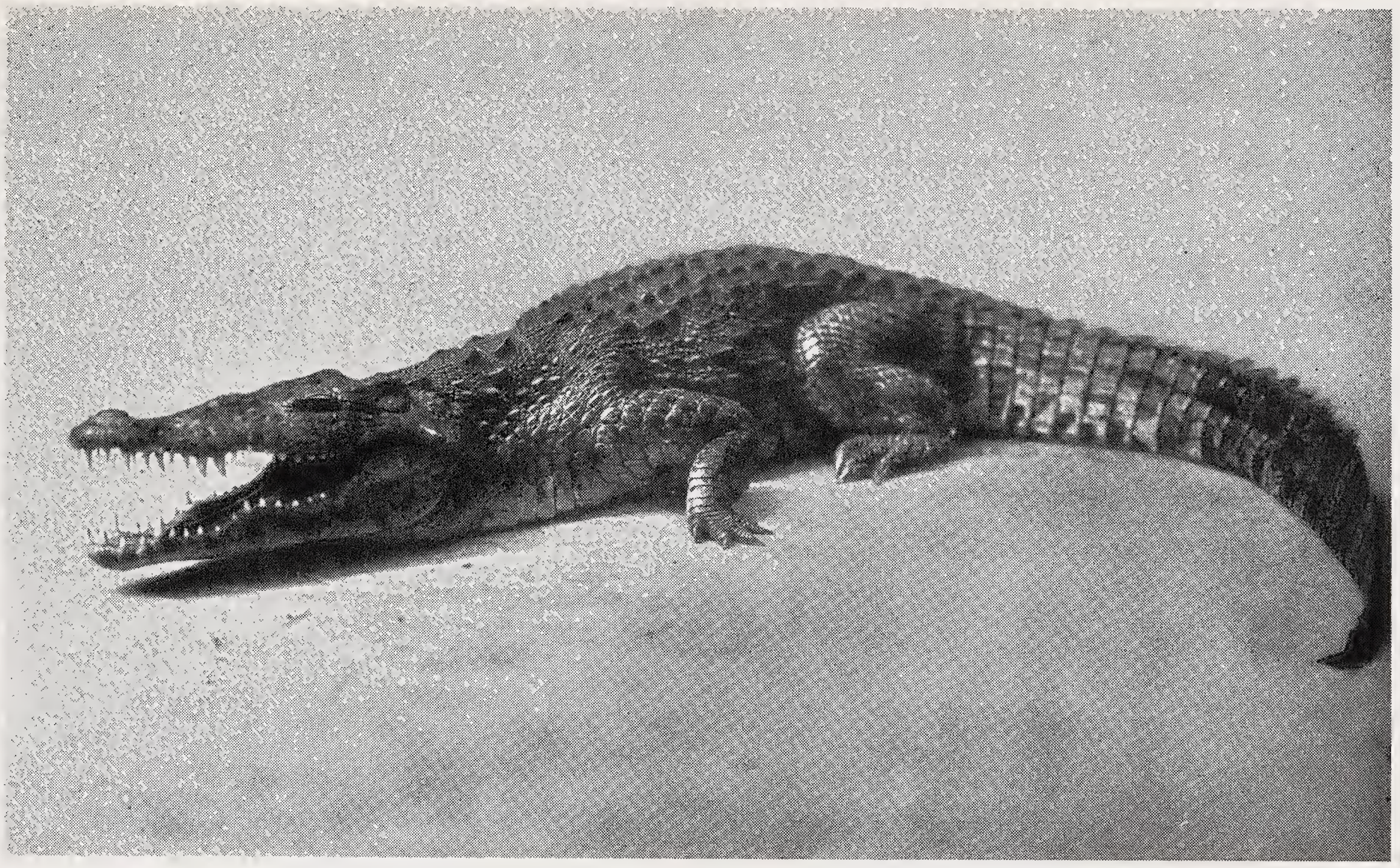
Two species of caymans, lacking spectacles and hence "smooth-fronted", are known from northeastern South America. From the Orinoco to the Amazon they may be seen in great numbers along the river banks, especially during the dry season. The smooth-fronted caymans were originally described by two eminent European naturalists of the early nineteenth century and are known respectively as Cuvier's smooth-fronted cayman, *Paleosuchus palpebrosus,* and Schneider's smooth-fronted cayman, *P. trigonatus.* At the end of the prolonged dry season, many river turtles, emerging from the mud in which they have aestivated, are actively pursued and consumed by these caymans. Such food might seem meagre fare were it not for the fact the species eaten is the largest of fresh-water turtles known, *Podocnemis expansa.* It is about three feet long and so abundant that thousands may be seen at one time on the cayman-infested river islets.

The Paraguay River, above the junction of its confluent, the Parana, is the home of a large species of black cayman, *Caiman yacare.* From this region the species extends through northern Paraguay into eastern Bolivia where it is well known in the river country. Its black markings and length of ten feet, with a fifty-six inch waistline are typical of adults. Both a robber and a cannibal, the Paraguayan cayman's habits have been recorded to some degree of length and with some amount of truth. Less likely tales are told of the females that form a circle about their young and fight off the hungry males; also of the females carrying the young, cat fashion, and placing them in small and sequestered pools

American Alligator. In captivity small specimens thrive and grow to adult proportions when kept in a sunny room with a constant temperature of at least 75 degrees Farhenheit. Food best suited to growth and development includes raw beef and fresh fish.



American Crocodile. Unlike its neighbor the alligator, the crocodile has a vicious disposition. When cornered it will give battle. It is feared by its captors and respected by its keepers. In pre-Columbian times the Mayas of Yucatan held the crocodile to be sacred and frequently propitiated its wrath with offerings of members of the tribe who were elected to give the community a fitting sacrifice. The creature is well represented in sculpture and pottery designs executed by the peoples of th Isthmian region.



Cuban crocodile. Restricted to Cuba and the adjacent Isle of Pines, the Cuban Crocodile offers a problem in zoogeography. In Cuba its range has been narrowed down in recent years to the almost inaccessible interior of the Zapata Swamp. One of the few specimens shown in captivity is to be seen in the Reptile House of the New York Zoological Park. It was captured by the author in 1929. *Photograph by Edward R. Osterndorff.*

where they will be safe from the powerful male cannibals of their family.

Caiman latirostris, so named because of its extremely broad-snouted appearance, is common on the east coast of Brazil from Pernambuco to the southern state of Rio Grande do Sul and extends into northern Argentine where it has been taken near Buenos Aires. It also may possibly be found in the upper courses of the Parana in the Paraguayan Basin but its location there awaits definite verification. The flesh of the creatures, especially that of the tail is reported to be excellent eating and Schomburgk is quoted as relating that their food is made up of fish and water-birds as well as the tender roots of aquatic plants.

Old World Crocodilians

The records of antiquity are replete with references concerning the Nile crocodile, its activities and the methods of its capture. Mummies of this crocodile are to be found in every archeological museum that houses an Egyptian collection. The technique used by the primitive hunter has changed but little since it was so entertainingly described in the forty-first chapter of the Book of Job. Historians have traced the land of Uz where Job lived as being on the eastern border of Palestine in Arabia. Here the tributaries of the Jordan, especially the Wadi Zerka, still harbours the beast of antiquity, the Nile crocodile, *Crocodilus niloticus.* The oft-repeated story of the plover that picked the reptile's teeth and gave it warning of approaching danger dates back to the fifth century before Christ when Herodotus in "Euterpe" wrote of his travels in Egypt. The belief concerning this custom has not been verified by actual accounts in the last fifty years but many African explorers still report that a plover, the *trochilus* of Herodotus, *Pluvianus aegyptius,* is often seen in close proximity to the Nile crocodile and it is not altogether impossible that it might dart into the open mouth of the monster to remove the leeches that infest its oral cavity and thus render it service. The crocodile's eggs seem to require a warm, dry bed of sand for incubation and, unlike most other species, unless this condition is possible the embryo is unable to develop, moisture causing it to rot. However, the species is so hardy that it breeds in places where

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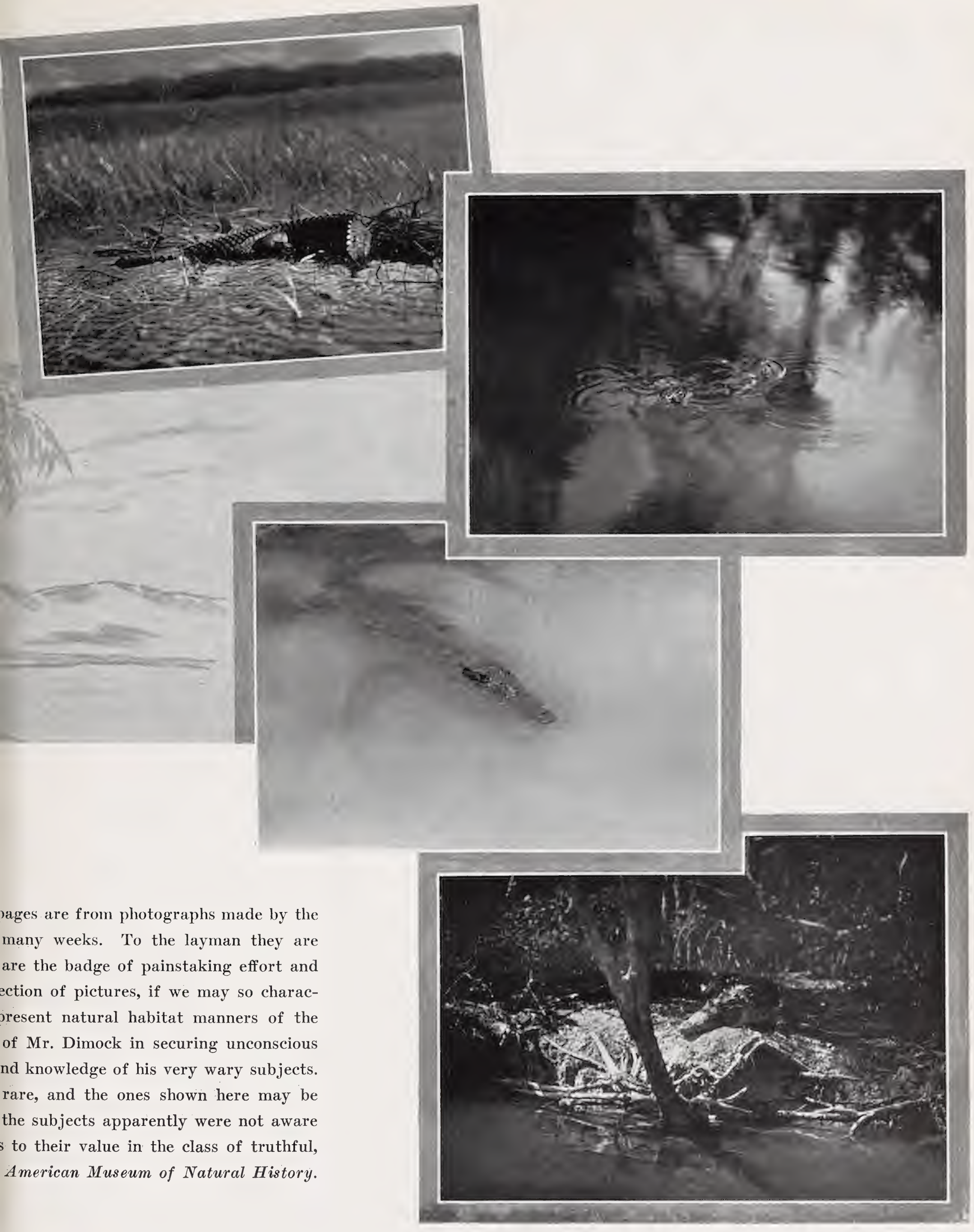

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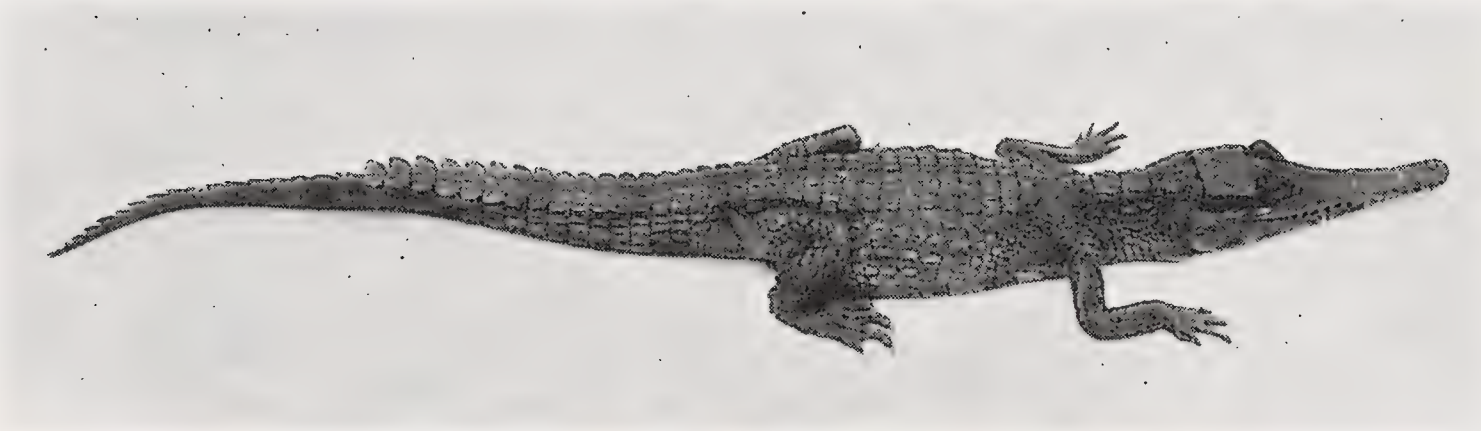
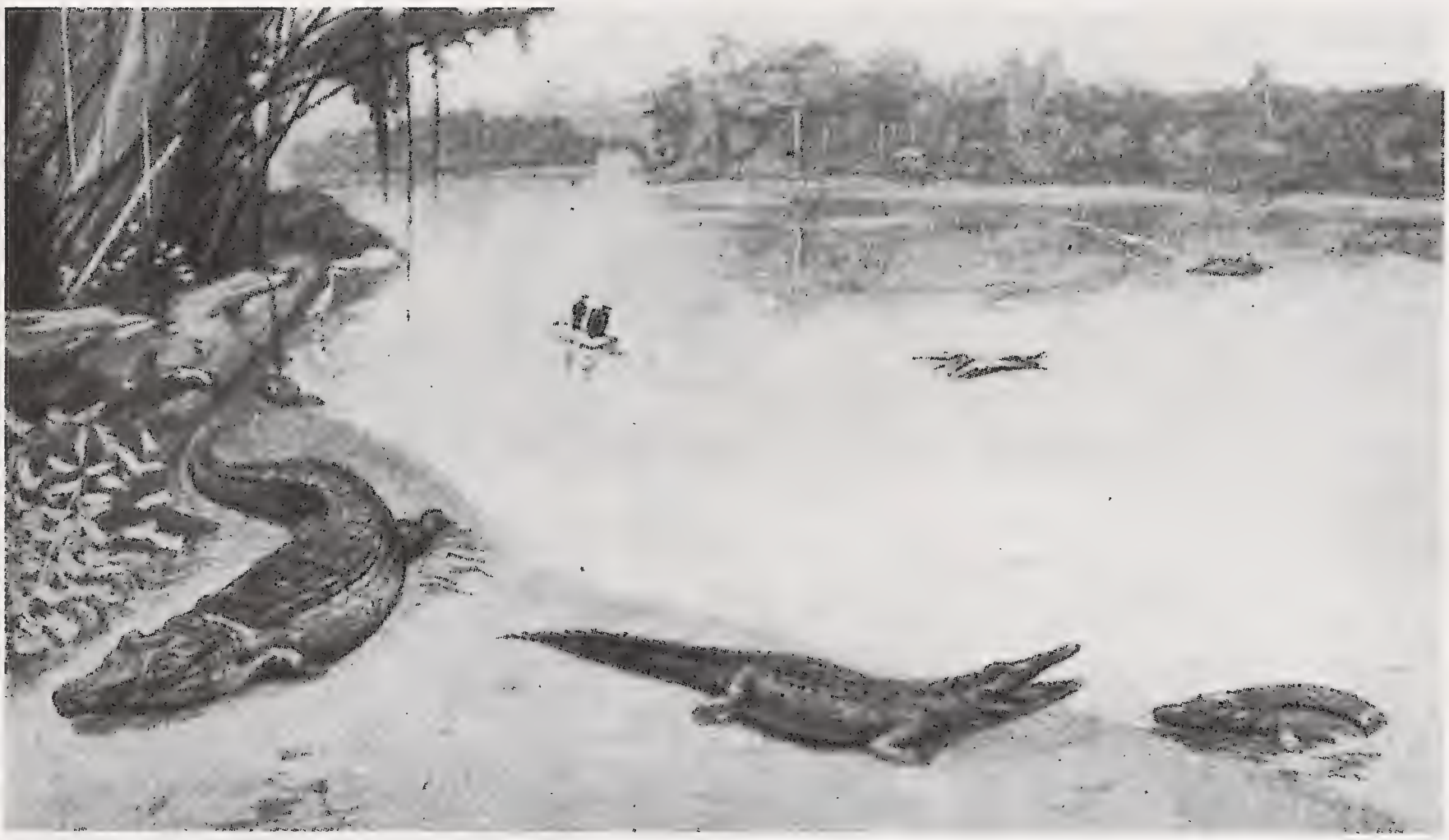
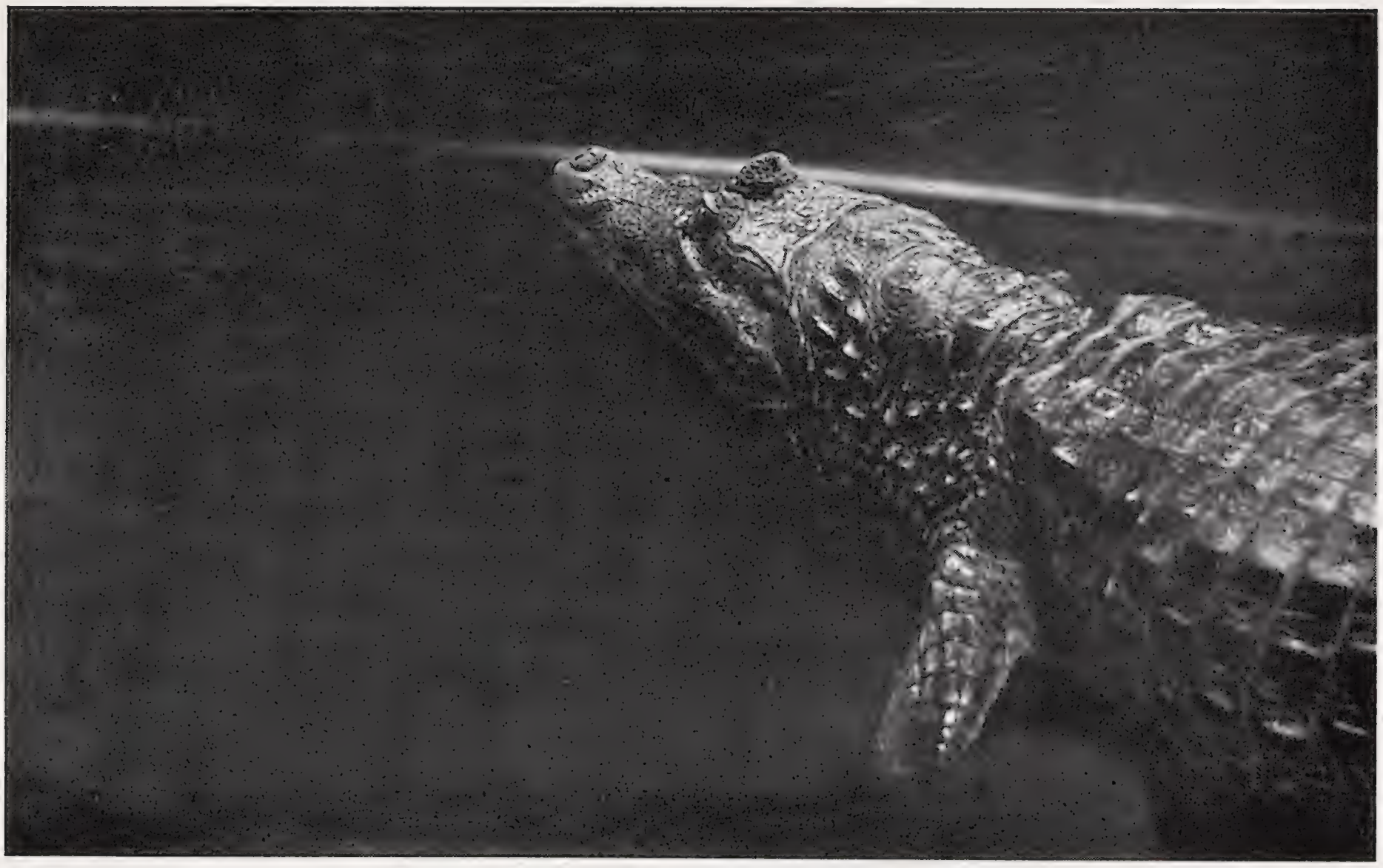
Central American Crocodile. In the summer of 1928 this species was rediscovered after a lapse of nearly a century. Dr. Karl Patterson Schmidt working near the Sibun Swamp of Guatemala found the species in relative abundance. *Photograph courtesy Field Museum of Natural History.*



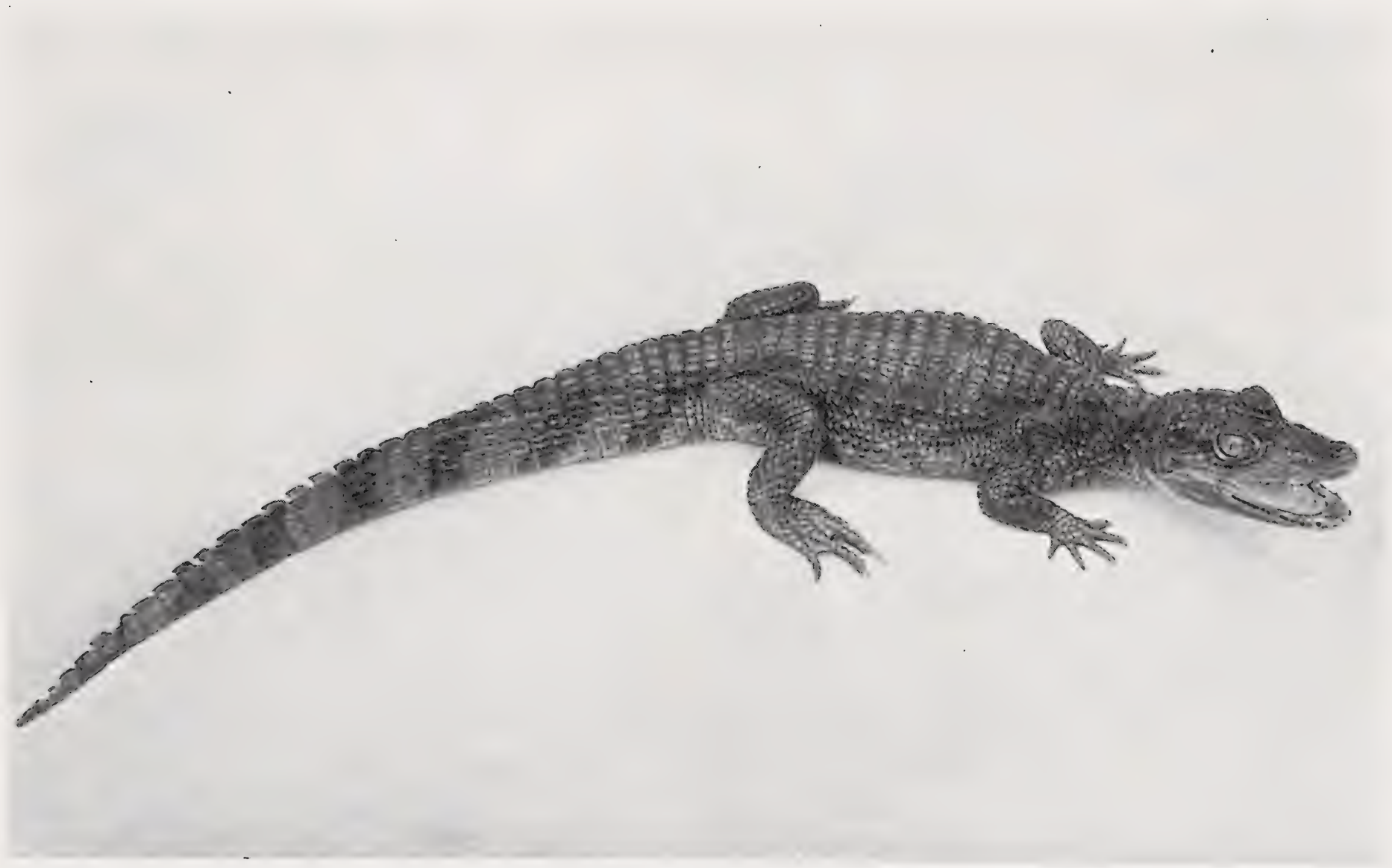
Orinoco Crocodile. A prolific species that lays from forty to fifty eggs in a clutch. These clutches are laid on the sandy river shores of Venezuela and the eggs, used for food by the natives, must be dug up from a depth of about a foot and a half.



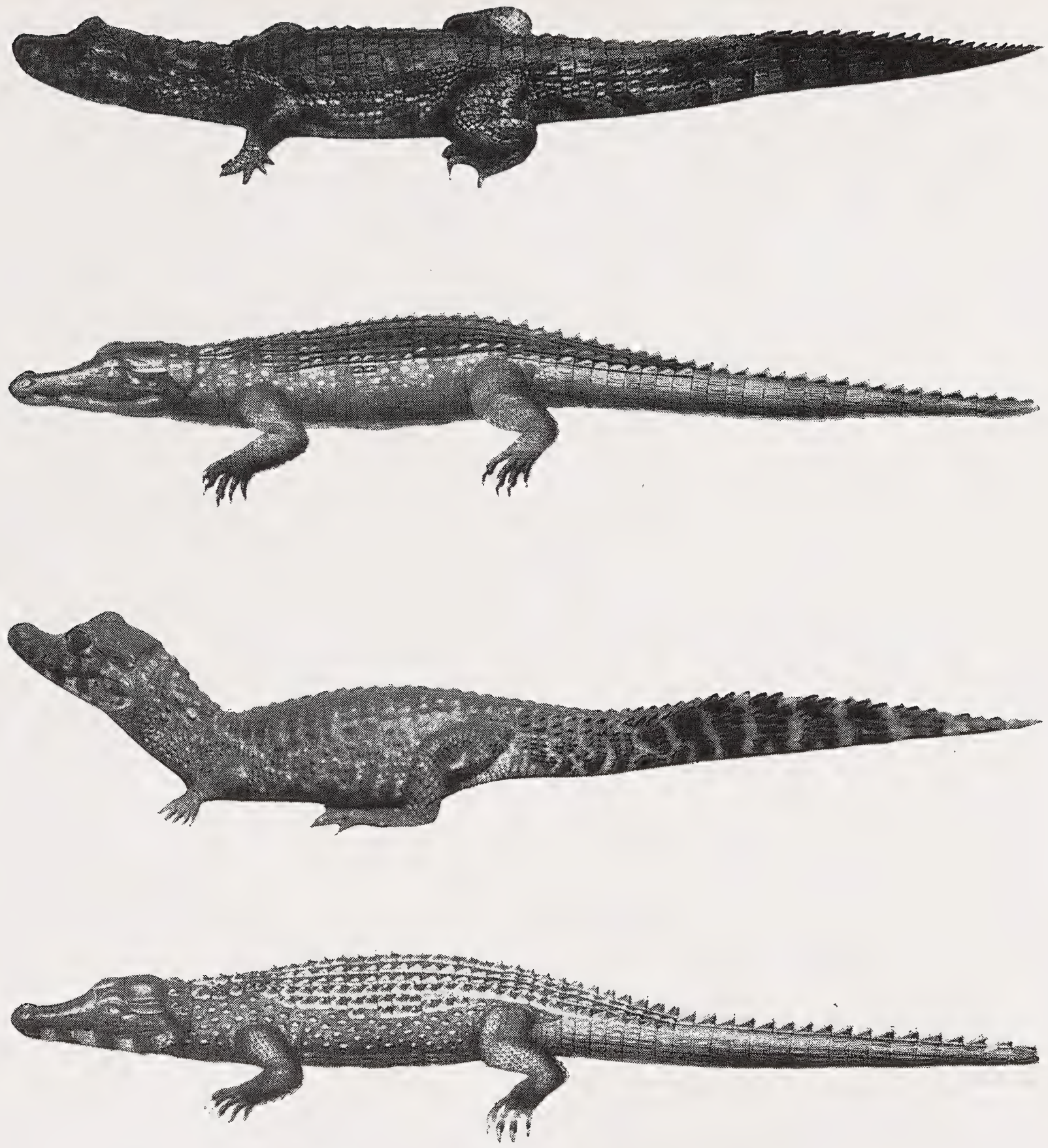
Central American Cayman. A small species inhabiting the tropical rivers of southern Central America and northern South America. Although well known to scientists and common in its habitat no photograph was available. In lieu of this a plate from the "Zoologia" of Dr. Perez Arbaelaez is reproduced. His background is that of the Magdalena River of Colombia.



Spectacled Cayman. A tropical American species.



Black Cayman. A specimen lately received from Brazil by the New York Aquarium measured eleven feet, eight inches. The one figured here is a juvenile example.



Reading from top to bottom. South American Caymans. a. Broad-snouted Cayman. b. Cuvier's Smooth-fronted Cayman. *From Tiedemann.* c. Paraguayan Cayman. *Courtesy Field Museum Natural History.* d. Schneider's Smooth-fronted Cayman. *From Tiedemann.*

the dry season is of only two months' duration. The number of crocodile eggs laid and hatched every year in Tanganyika (formerly German East Africa) is most surprising. Mr. Arthur Loveridge, who visited that country in 1922, shows that during the first six months of the year, 120,-502 eggs were brought in for a bounty. The Tanganyika Government records that deaths from crocodiles in the whole of its vast territory do not exceed fifty natives a year. This is a very small percentage of fatality in a population of three and a half million inhabitants. Equally significant are the records of African expeditions that have spent many years in the field. Such an expedition, led by Mr. Herbert Lang, of the American Museum of Natural History, ten years in the Congo region, dealt with several hundred thousand natives "and yet in all that time not one authentic case of loss of human life due to crocodiles came to our attention".

The West African sharp-nosed crocodile, *Crocodilus cataphractus,* is a large species which, true to its name, is restricted to the western portion of the Dark Continent. In general, its habits little set it apart from its relative of the Nile. Like that species, it has long been associated with a bird that supposedly tends to its dental ailments. This avian surgeon is the spur-winged

plover, *Hoplypterus spinosus*. Again, no direct evidence bears on the validity of the many tales concerning this bird, but the same line of argument exists. Rumors to the contrary, the beast is little feared by the African natives of the great river systems.

The West African rough-backed crocodile, *Osteolaemus tetraspis,* shares the common habitat of the foregoing Ethiopian species. It is one of the smallest individuals of the order of Crocodilia and seldom attains to five feet. It is respected, however, by the local tribes who erect palisades around their bathing spots in the rivers so as to ensure a tranquil bath. This crocodilian is often found in salt or brackish-water where its upturned snout is useful in keeping its head above choppy waves. Little is definitely known concerning its habits and much remains to be learned about its breeding, food and growth.

The West African smooth-backed crocodile, *Osteoblepharon osborni,* named in honor of Prof. Henry Fairfield Osborn, is a recently discovered species. Inhabiting the forest region of the northeastern Congo it is characterized superficially from its ally, the rough-backed crocodile of West Africa, by a flatter and slenderer snout. Fish is its principal food. While it is known that natives loot the nests of this species and utilize the eggs for food, nothing further is recorded concerning its habits.

The Indian gavial, *Gavialis gangeticus,* the giant of the crocodilian world, is found in the water systems of British India and commands front-rank position for size in the order of Crocodila. Adults are said to attain a length of thirty feet and fossil finds of this genus are more than fifty feet long. The newly hatched representatives of this gavial measure some fifteen or sixteen inches, nine of which is taken up by their slender and emaciate-looking tail. The eggs are deposited in tiers of twenty above and twenty below, separated by a foot of sand.

The Indian mugger or swamp crocodile, *Crocodilus palustris,* a medium-sized monster of twelve feet, is found in almost every bog and swamp from Baluchistan in northern India to lower Burma and the Malay Peninsula, as well as in Ceylon and Java. However, during severe drought, it has been observed that they leave the dried up water courses and traverse considerable areas in search of water. It is dark-olive or blackish above, the young a pale olive spotted with black. While the species is cannibalistic it does not molest man and is noted for its remarkable timidity. During the long dry season it aestivates in the mud where it remains in a state of torpor until the recurring rains release it.

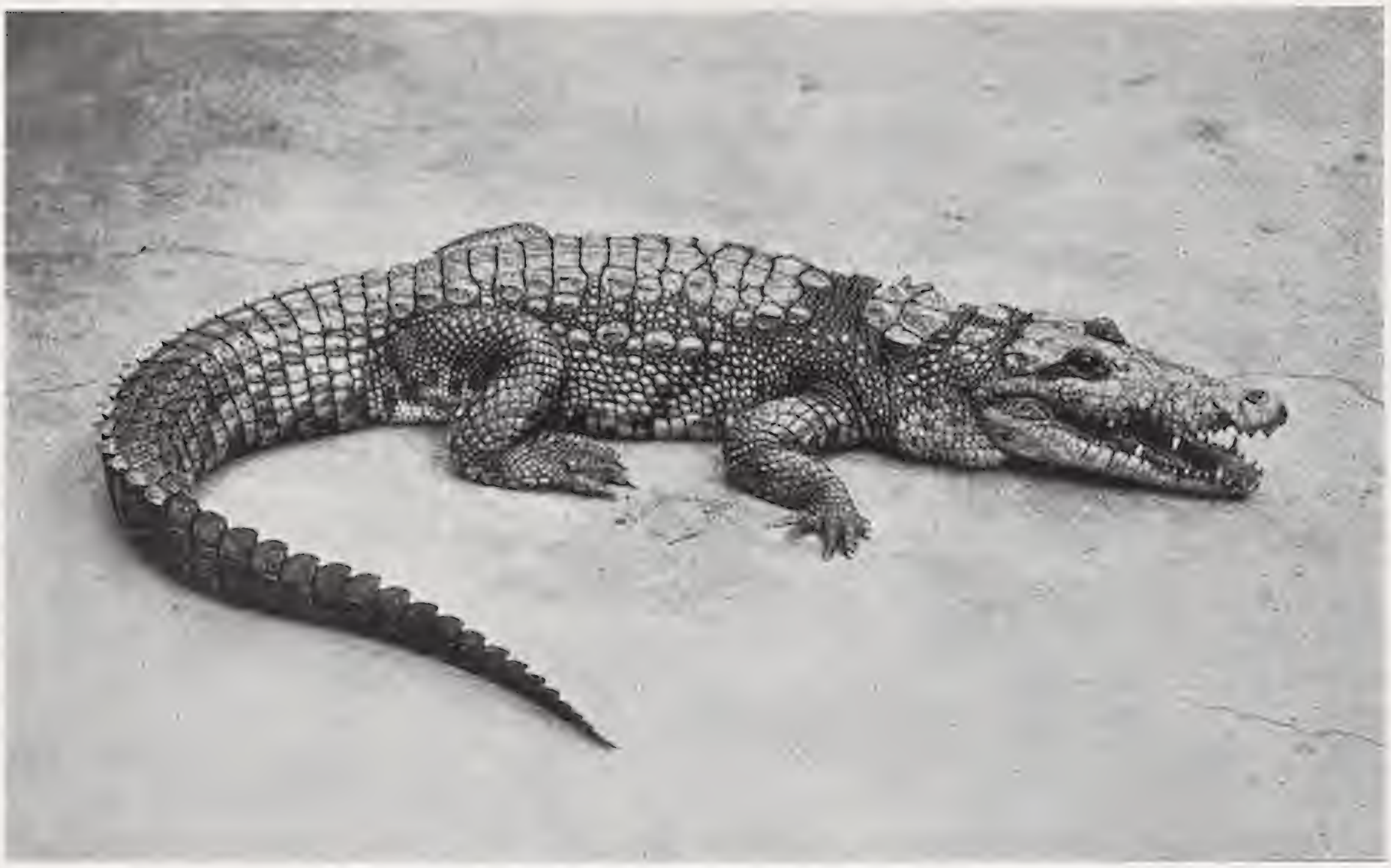
Siam, among the many curiosities of natural history, harbours a crocodile, *Crocodilus siamensis,* which is also known in French Indo-China and Java. It is a small species, about seven feet in length, and is native to the rivers and swamps of the Malay Peninsula. In these countries it is equally at home in both fresh and salt-water. Little or nothing is known about its habits and much remains to be studied in the region of its habitat. It is of dark-olive coloring, spotted with black and grows to about seven feet.

The salt-water crocodile, *Crocodilus porosus,* is an estuarine species frequently seen swimming in the ocean, many hundreds of miles from land. Undoubtedly this natatorial activity accounts for its presence in many distant countries of the East and is the reason for its wide distribution. This reptile is common from the Philippines to South China, through the East Indies to New Guinea and the Solomon and Fiji Islands. In India it is restricted to the Malabar coast and to the tidal waters of Ceylon.

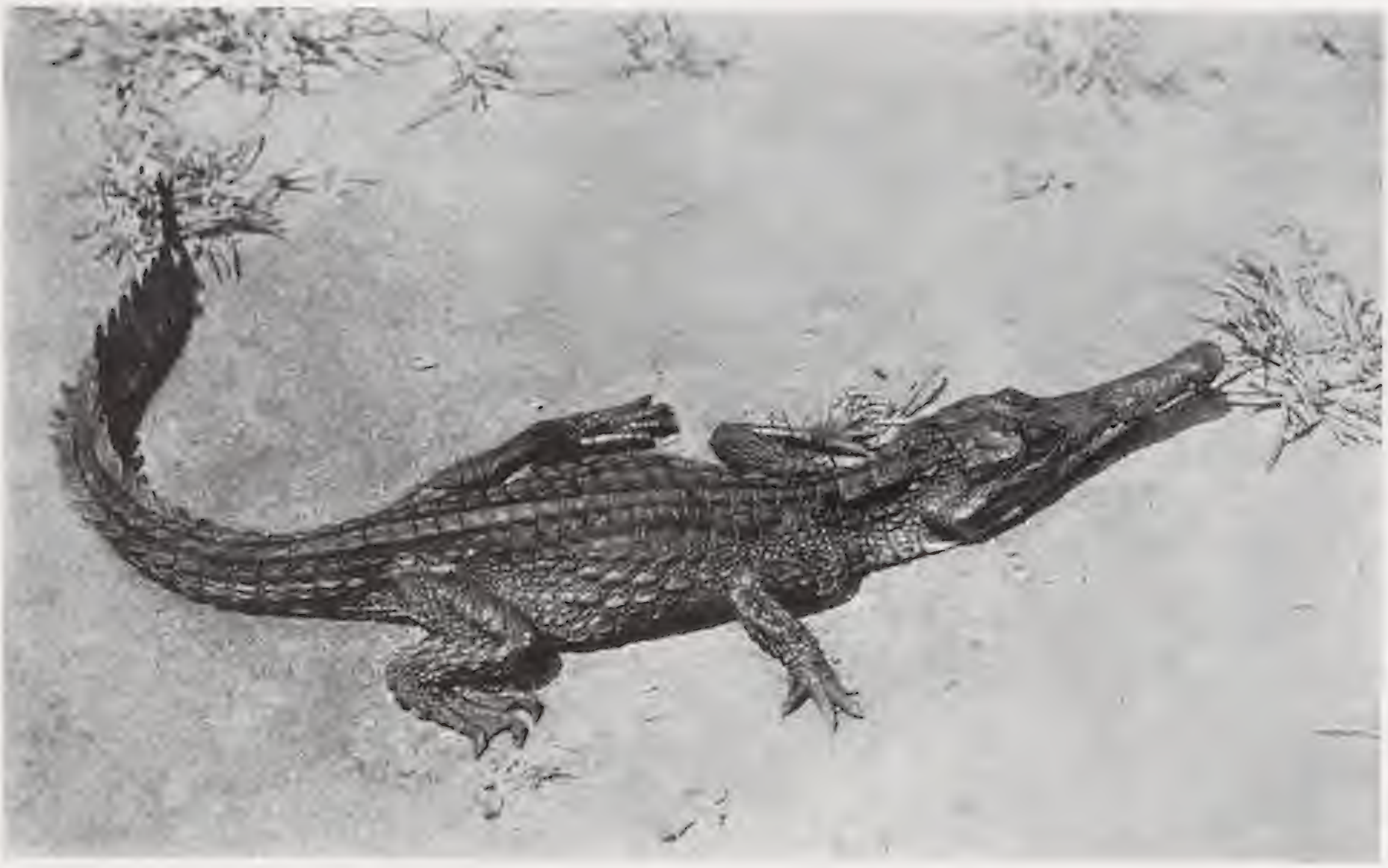
A recently described and little known species is one from New Guinea. In 1908, Dr. George A. Dorsey of the Field Museum, in undertaking some ethnological studies in Melanesia secured several crocodilian skulls from the territory around the lower Sepik River of northern New Guinea. It was not until 1928, however, that this material was examined and described by Dr. Karl Patterson Schmidt as a new species of crocodile, *Crocodilus novae-guineae*. Schmidt's diagnosis is clear, pointing out that the species is intermediate between the salt-water crocodile and the Australian one.

The bushmen of Queensland regard the Australian crocodile as harmless. Its salt-water neighbor, *C. porosus,* however, is man-eating. Charles Barrett, the Australian naturalist, records its reptorial activities and gives some hint of its annual toll of human lives.

Many specimens of the Australian species are shipped to zoological parks all over the world and the method of their capture is as follows: A spring trap, made from bent mangrove branches,



Nile Crocodile. The crocodile of the Nile is the largest species found on the African continent and has a distribution nearly equal to the widespread salt-water crocodile of the Orient. It is found in all parts except in the Sahara and certain parts of arid North Africa. In the island of Madagascar it is the most common vertebrate known and a denizen of nearly every body of water.



West African Crocodile. The jaws approach the narrow head outlines of the Indian Gavial. Stomach content shows that the species lives on fish, shrimp and frogs.

Rough-backed Crocodile. A West African species that enters into the salty river mouths of its habitat.

Smooth-backed Crocodile. A recently discovered species named in honor of Prof. Henry Fairfield Osborn by Dr. Karl P. Schmidt. Taken by Mr. Herbert Lang in West Africa. *Photograph courtesy American Museum Natural History.*

is set; a running noose is then attached to this trap and placed near a watercourse that is known to be a favorite run of the animal. A loop of the noose suspends some bit of game or meat and the crocodile, in its efforts to get this morsel, fastens himself in the noose, thus facilitating the capture of live and uninjured individuals.

The Malayan gavial, *Tomistoma schlegeli,* approaching a length of fifteen feet, is the third largest crocodilian in Asia. This gavial is an olive-green color, spotted with pale brown above; its tail is banded. The iris of the eye is a yellowish-brown. Its evolutionary position closely parallels that of its Indian relative and owing to the fact that it has a somewhat broader skull, it is often assigned a place between the gavial of India and the true crocodiles. In appearance it greatly resembles the fossil restorations of its prehistoric ancestors. It is hard to believe that a creature of such terrible countenance can be harmless, but again its elongated jaws determine its diet of fish and so unfit it to prey on man.

It is always interesting to contrast attitudes of native peoples with those of their more civilized brethren. Some of the Malay people venerate their *gharial* to the point of ascribing to it a divine origin. Washerwomen, beating their clothes in its rivers, utter prayers of gratitude to the animal whose presence protects them from evil spirits, while in our own country, the alligator is looked upon with mingled feelings of fear and loathing; curiously enough, it is quite as harmless to man as is its Malayan and Indian allies.

The Chinese alligator, *Alligator sinensis,* is one of the smallest of Asiatic crocodilians. It frequents the waters and tributaries of the Yang-tse River, living on fish and whatever water-fowl it can capture. In character and habits it closely resembles its American relative. Its skin is greenish-black above, speckled with yellow and green beneath. These river people of China regard the reptile as a pest rather than an enemy inasmuch as it constantly preys on ducks and becomes ensnared in fish-traps. This same habit has been observed in Africa where game hunters complain that crocodilians frequently fill traps set for other animals.

References

The following works are listed either because of their bibliographies, their illustrated texts, or a happy combination of these factors. As over five hundred papers were consulted in the preparation of this review of the crocodilians it is not feasible to list them all. However, this selected list will lead the inquisitive reader far into the field of crocodilian literature.

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Ditmars, Raymond L. (1930) Reptiles of the World, pp. 63-87, illustrated. The Macmillan Company, New York City. "A recent edition of this popular textbook by the best known American Herpetologist".

Gadow, Hans (1928) Amphibia and Reptiles, pp. 434-472, illustrated. Cambridge Natural History, Vol. VIII. The Macmillan Company, New York City. "A classic treatise by a well-known naturalist".

Kellogg, Remington (1929) The Habits and Economic Importance of Alligators, 36 pp., illustrated. United States Department of Agriculture, Technical Bulletin No. 147. Washington, D. C. A definitive essay on the American Alligator.

Reese, Albert M. (1915) The Alligator and Its Allies, 358 pp., illustrated. G. P. Putnam's Sons. New York and London. "A scientific treatise written in popular fashion, and with a good bibliography".

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(1928) Notes on South American Caimans. Ibid., Vol. 12, No. 17, pp. 205-231, illustrated.
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Williston, Samuel Wendell (1914) Water Reptiles of the Past and Present, pp. 184-215, illustrated. The University of Chicago Press, Chicago, Illinois. "A popular work presented in an interesting manner".

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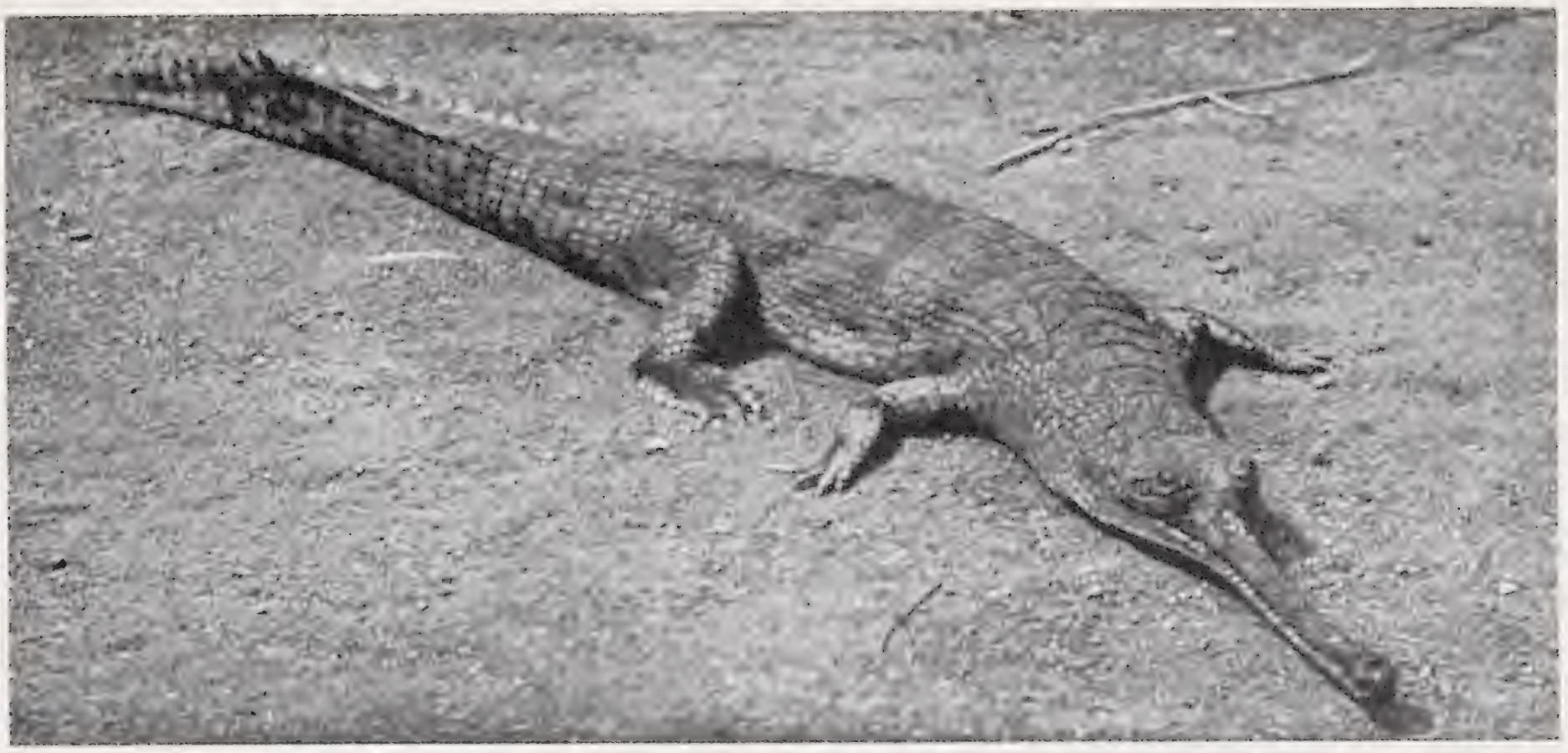
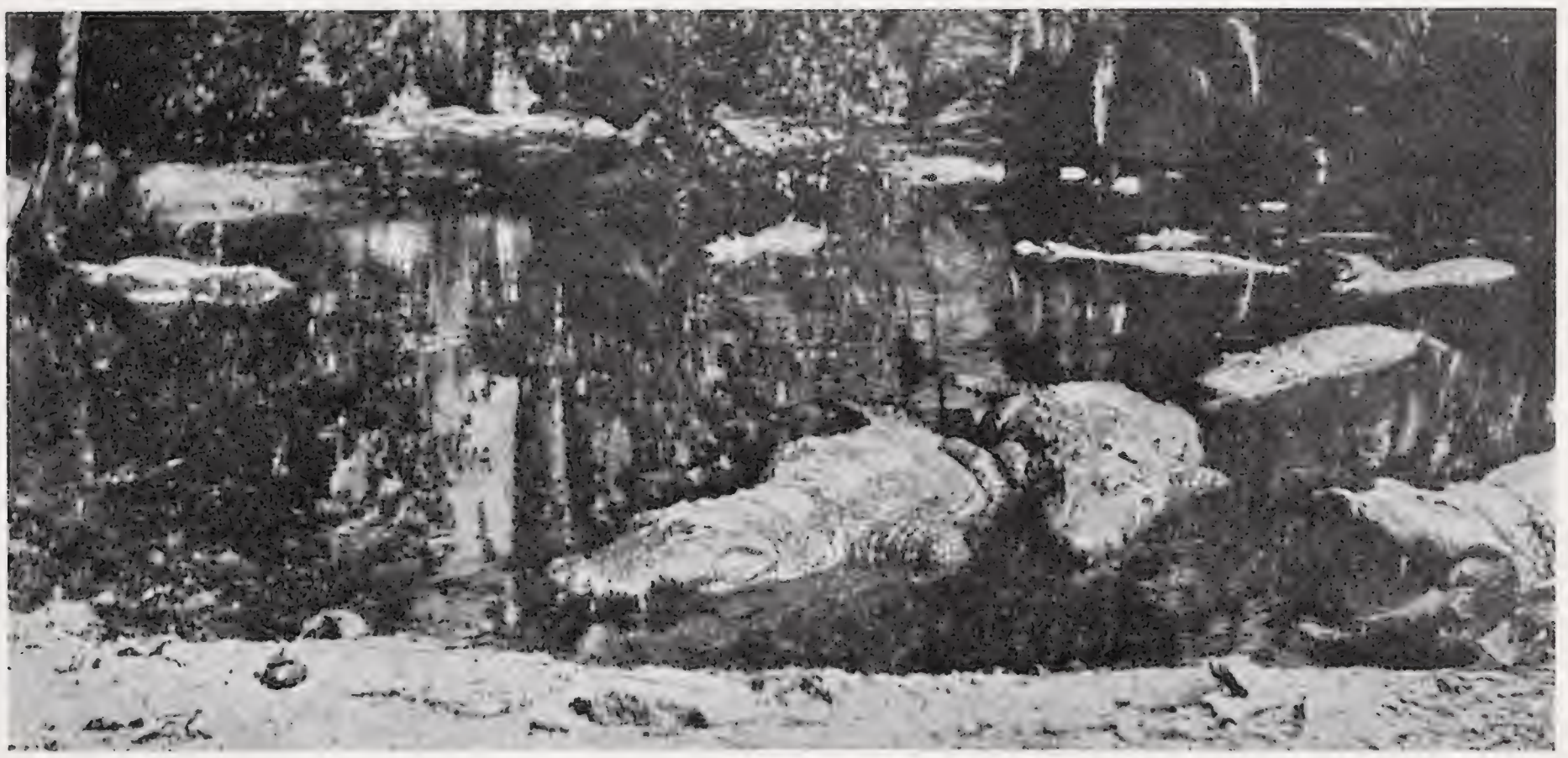
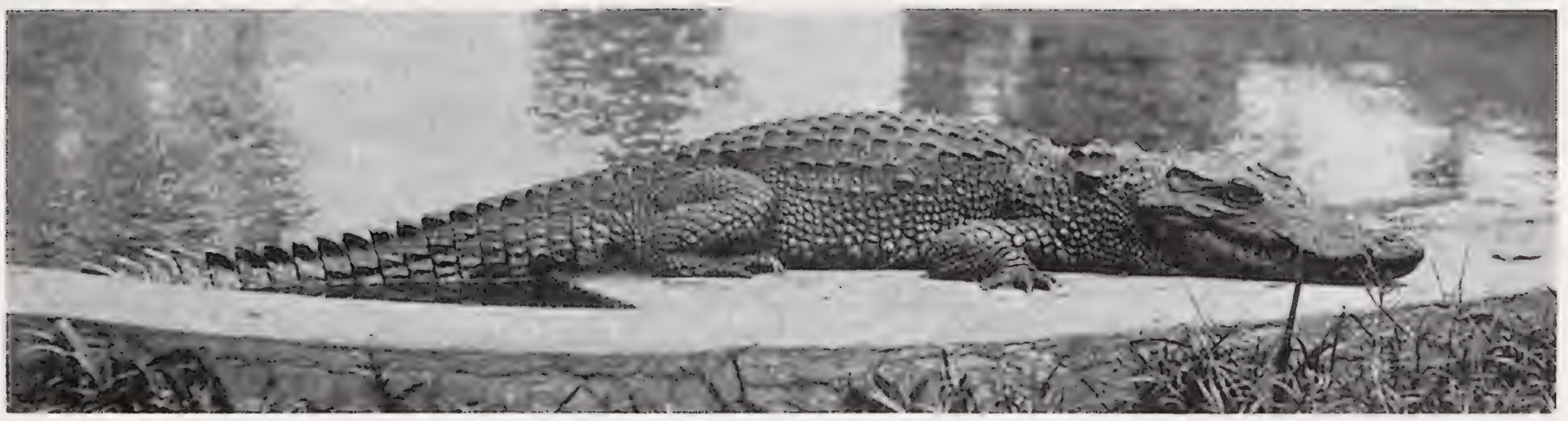


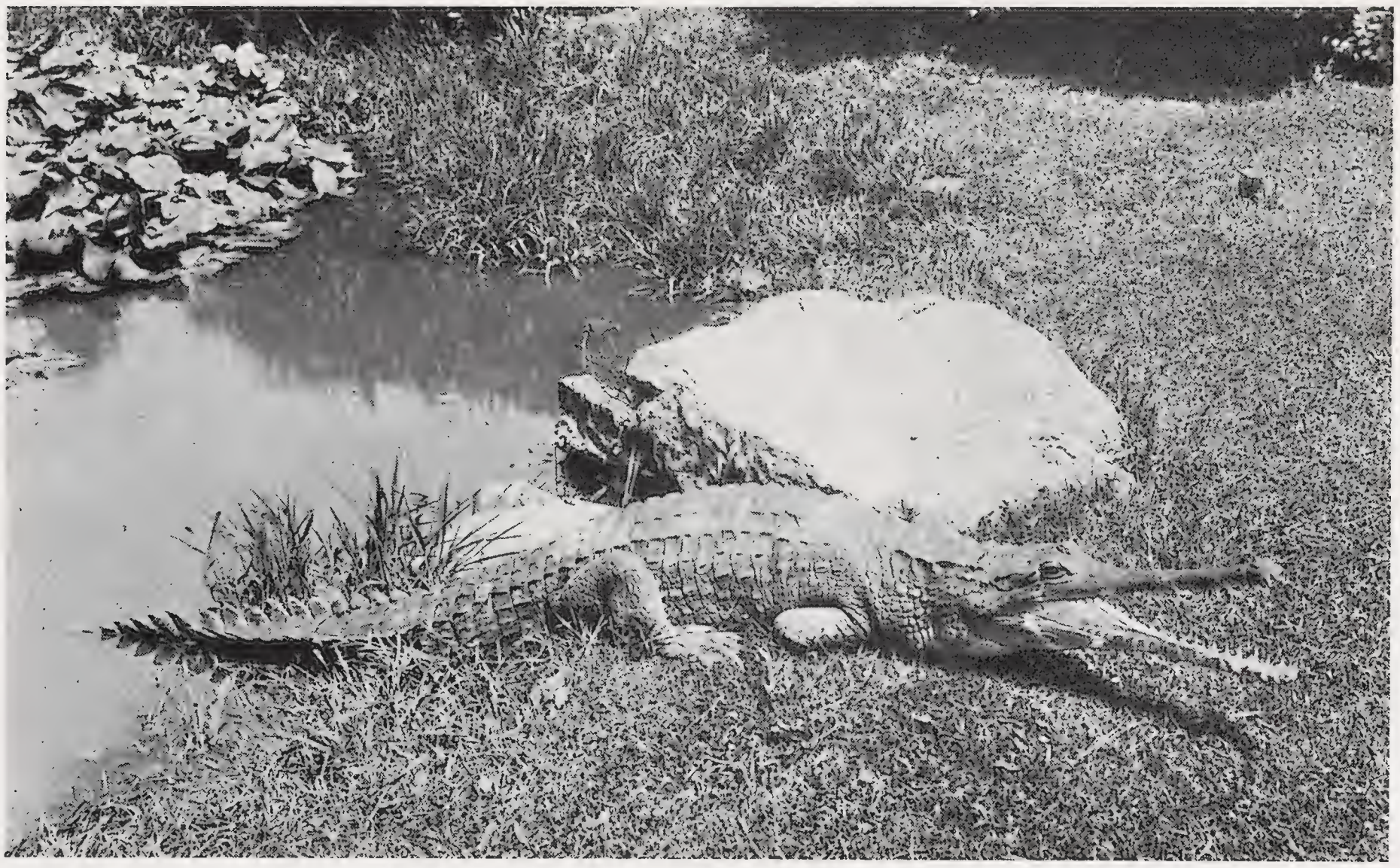
Indian Gavial. Said to be one of the most primitive types of reptiles. Inhabits the Ganges River, and is so designated by its name, *Gavialis gangeticus*. The generic name, 'gavial', is a corruption for 'gharial', a Hindustani word signifying a fish-eater. *From Brehms after Berridge.*



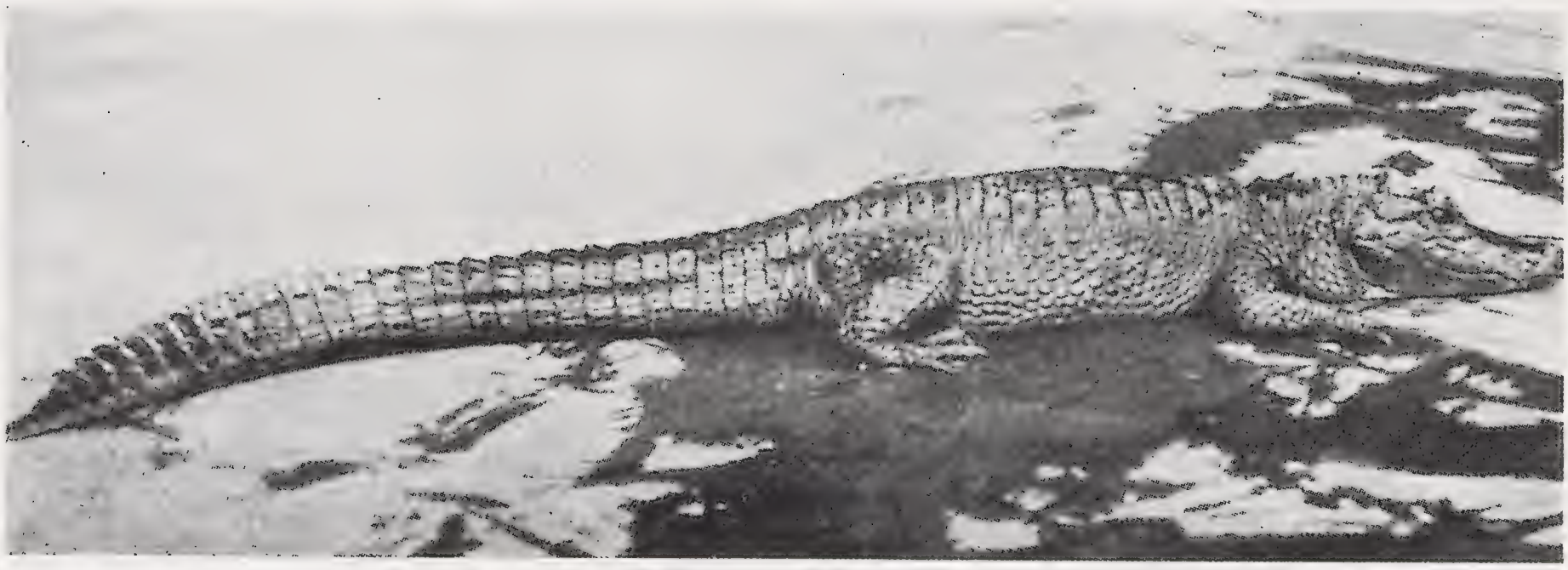
Indian Mugger Crocodile. The Mugger is venerated by the Hindoos and in the past was frequently kept in temples. Here, as in other tropical lands, the 'stomach stones' are used as charms and are supposed to have curative as well as preventative virtues. *From Flower.*



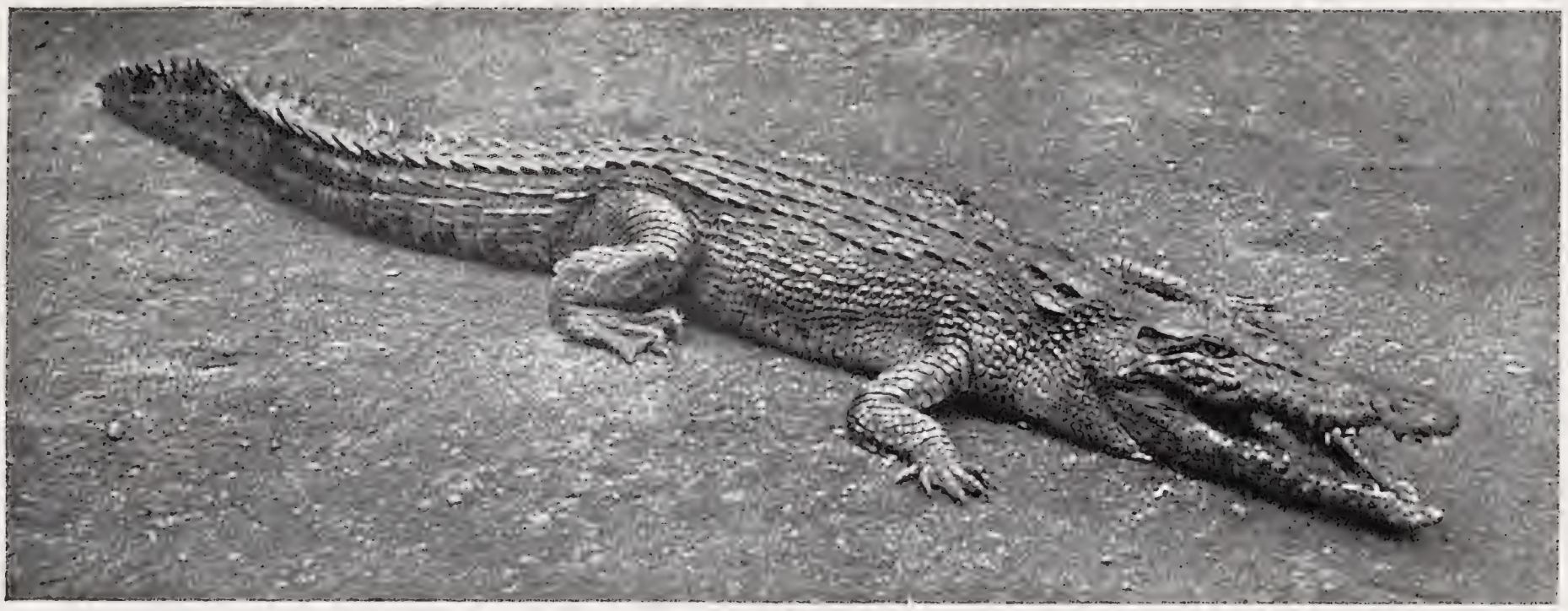
Siamese Crocodile. It is related that the Annamites of Indo-China tether specimens of this species to the piles on which their houses are built. The flesh is relished and sold in the same manner as pork. *Photograph courtesy of Dr. Malcolm A. Smith.*



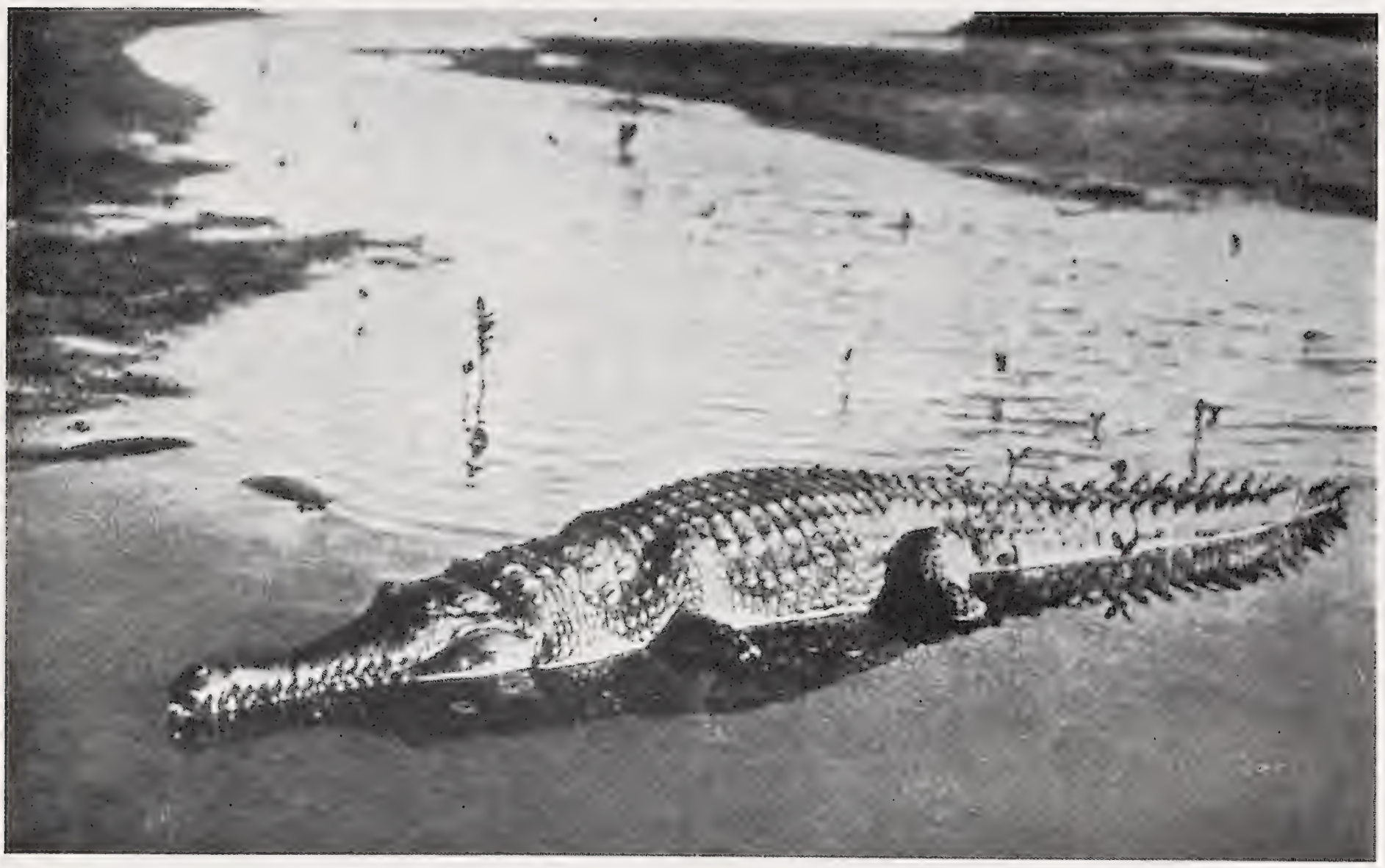
Malayan Gavial. Its elongated jaws indicate its diet to consist largely of fish.



Chinese Alligator. The Cantonese use the skin of their native alligator for the percussive heads of their stringed instruments and collect its teeth for their alleged medicinal properties. Its scales are also used for treating fevers, goitre and skin diseases. *From Brehms after Berridge.*



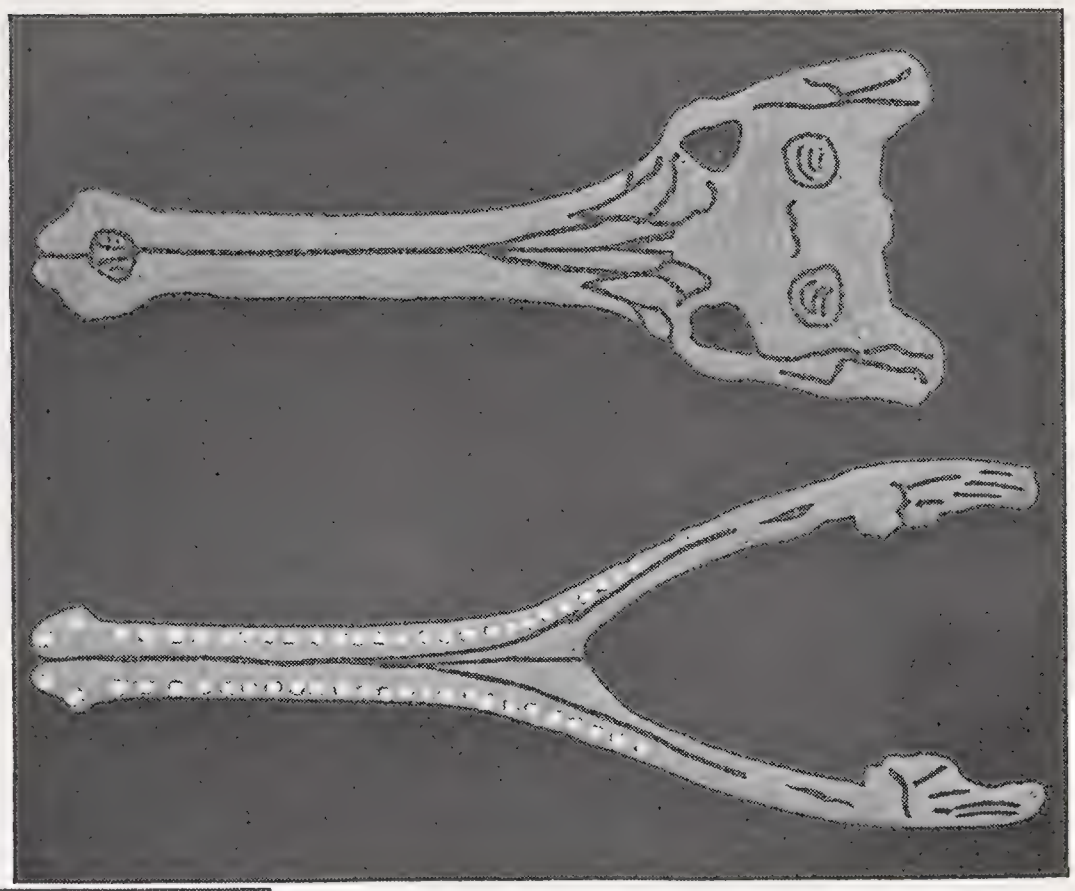
Salt Water Crocodile. In India over two hundred deaths a year are said to be caused by this species. The British have offered bounties for the destruction of this crocodile and its eggs. In size and bulk it is the second largest crocodilian in the world, growing to over twenty feet. *From Brehms after Berridge.*

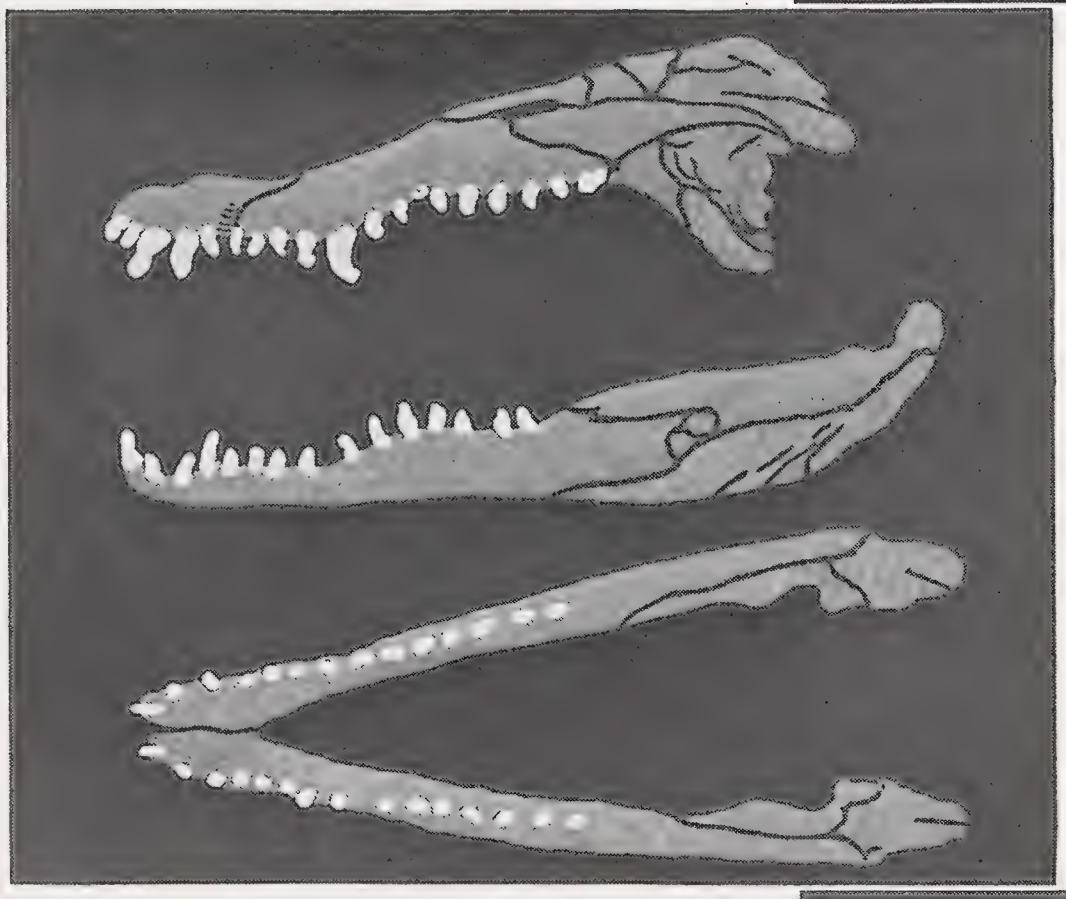


Australian Crocodile. Northern Australia is the home of *Crocodilus johnstoni.* Eight foot specimens are common throughout the freshwaters of northern Queensland and, in days past, larger sizes were reported. *From National Geographic.*

1. Indian Gavial skull showing the typical conformation of the Gavial group.

2. Jaw of Indian Gavial showing the fusion of the two halves of the lower jaw extending beyond the fifteenth tooth. This is a diagnostic characteristic of the Gavial group.





1. American Crocodile skull showing the exposed notch for the fourth tooth of the lower jaw. This is a diagnostic characteristic of the Crocodile group.

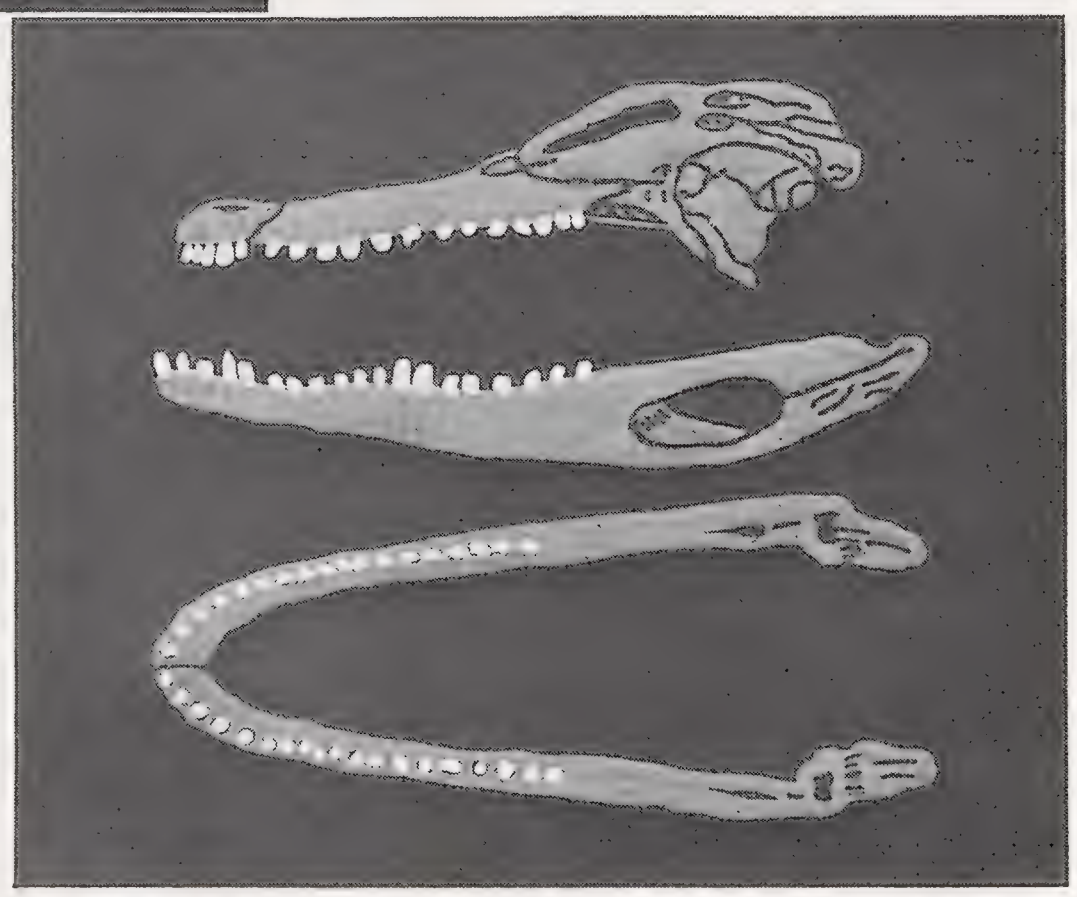
2. American Crocodile jaw, lateral view showing the much enlarged fourth tooth typical of the Crocodile.

3. American Crocodile. Lower jaw showing fusion of the two halves extending to the fifth tooth.

1. American Alligator skull showing space between the fifth and sixth tooth. This pit is characteristic of the alligators and caymans.

2. American Alligator. Lateral view of the jaw showing the elongated fourth tooth which fits into the pit mentioned above.

3. American Alligator. Lower jaw showing the broad spade-like shape, characteristic of most members of this group comprising the alligators and caymans.



Osteology of the Principal Crocodilians. (*Top*) Skull and jaw of the Indian Gavial, *G. gangeticus*. (*Center*) Skull and jaw of the American Crocodile, *C. acutus*. (*Lower*) Skull and jaw of the American Alligator *A. mississippiensis*.

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Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

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Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

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Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. 21 editions issued. Published as needed.

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Panorama: Bird's-eye View, Zoological Park (*out of print*).
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Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
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The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

For all publications, other than those referring to the Aquarium or Aquatic Life — address: H. R. Mitchell, *Manager, 185th St. and Southern Boulevard, New York City.*

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Sea Shore Life (Mayer); 181 pp. 119 ills. Out of print. To be re-issued.
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend); 17 pp. 21 ills.
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger); (*out of print*).
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Fishes in the Home (Mellen); 178 pp. 63 ills.
The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs. In boards.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs. In boards.

For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues wil be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Manager, Zoological Park, 185th St. and Southern Boulevard, New York City.*

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Vol. XXXVI, No. 2 March-April, 1933

Contents

DOREEN—*From a Painting by Margaret S. Johnson* ..... *Frontispiece*

THE QUEST OF THE BONGO ..... *Col. E. Percy-Smith* 27
From the Illustrated London News

THE BONGO IN THE ZOOLOGICAL PARK ..... *Claude W. Leister* 33

THE HARNESSED ANTELOPES ..... *Raymond L. Ditmars* 38

TRAGEDY AMONG ROYAL PACHYDERMS ..... *Dr. E. B. McDaniel* 47

"SHORE FISHES OF BERMUDA" ..... *Review by W. Reid Blair* 51

MAP, DISTRIBUTION OF THE BONGO 35

THE BONGO ..... *Portrait of Doreen Cover*
From an original drawing in water colors by Paul Bransom, donated to the Bulletin.

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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THE BONGO IN THE ZOOLOGICAL PARK

From a painting in oil colors by Miss Margaret S. Johnson

A portrait of Doreen painted in January 1933, shortly after her arrival at the Zoological Park. The reproduction shows to good advantage the truly beautiful color of this graceful antelope, one of the rarest of the varied and abundant African faunal-life. The vertical, white striping, typical of the harnessed antelopes, stands out vividly against the rich chestnut-brown of the body, greatly enhancing the warmth of the varying tones. Oddly enough these stripes, which prevail in both sexes, are of unequal number on opposite sides. African antelopes in captivity have rather garrulous dispositions. Frequently they are both savage and aggressive. Doreen is a perfect antithesis. She is both placid and tractable, and so perfectly calm as to convey the impression of an inheritance of domesticity of primeval origin. The picture has been purchased by the New York Zoological Society for the Gallery of Animal Paintings in the Zoological Park.

BULLETIN
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The Quest of The Bongo

From "The *Illustrated London News*" of August 27, 1932

Permission to re-print the story by Col. E. Percy-Smith of the capture of Doreen, as related in the Illustrated London News, was made possible through the kindly offices of Mr. Bruce Ingram, the Editor. He also forwarded to me the original photographs illustrating the article, with the rights of reproduction granted by The Cambridge Literary Agency, the London Agents of Col. Percy-Smith. Photographs, except mounted specimen of the British Museum, exclusive to "The Illustrated London News." World copyright strictly reserved.—Ed.

"IN the course of a fairly adventurous life," writes Colonel E. Percy-Smith, "I have been fortunate enough to secure, at different times, a good deal of big-game shooting and of specimen-collecting for various museums. My interest in wild animals, thus aroused, has continued to grow; but I find, as so many other shikaris have done, that my desire to kill them has vanished in proportion. And so it came about that I thought of attempting the capture of some really rare creature, which had never as yet been seen in Europe. For that reason it could be readily disposed of, and my hobby would then, to some extent, be self-supporting—no small consideration in these hard and uncertain times.

"I had known Kenya Colony well for many years, and enjoyed in the past much kindness from my many good friends there. This fact, with its unique facilities for big game and the possession of a delightful climate, combined to make it the most suitable country under the British flag for my purposes. And once Kenya was decided upon, the bongo inevitably became the object of my quest. The rarest, as it is almost the largest, of East African antelopes, it has its home in the dense mountain forests, at the height of some nine thousand feet or so. Its horns make a massive and yet gracefully spiralled trophy. It has a brilliant chestnut coat, with curiously striped markings; in short a beautiful and imposing creature, entirely belieing its uncouth zoological appellation, *'Boöcercus Isaaci'*.

"As the animal lives in the thickest forest, where a noiseless approach is well nigh impossible and is endowed as well with a hearing uncannily acute, one cannot wonder if it is rare even to catch a glimpse of it. How much more difficult then, was the problem of catching one alive and uninjured, and that within the limits imposed by the Game Laws, which rightly prohibit such cruel, if effective, methods as running wild game down with dogs or snaring them in promiscuous pits? The forest terrain also put out of the question the idea of driving them into nets. I decided, therefore, to attempt two methods; the first and more promising to build a stockade round a favourite salt-lick, at the edge of the forest, to which their fondness for this delicacy would, I felt sure, inevitably attract the bongo; the second, to set nooses at a suitable height along some trails that they were wont to frequent. Knowledgeable friends on board the steamer were helpful with their advice, and enabled me to decide on the eastern slopes of the Aberdare Mountains as the scene of my endeavours. This magnificent mountain range lies half-way between the Great Rift

A Bongo—rarest of antelopes, and never seen alive in Europe—A young female recently captured in the mountain forests of Kenya.

The capture of a living bongo, the rarest of East African antelopes, of which no living specimen has yet been seen in Europe, is an event of exceptional interest. In an article with further photographs given on succeeding pages in this number, Colonel Percy-Smith describes how, after great difficulties and vicissitudes, he succeeded in snaring the beautiful creature shown above, in the forests of the Aberdare Mountains, half-way between the Great Rift Valley and Mount Kenya. This bongo is a young female, and has been named Doreen. Colonel Percy-Smith describes her brilliant chestnut colour and curious striped markings, with a thick ridge of hair along the spine.

Valley and the even more imposing *massif* of Mount Kenya itself. Thither, after collecting my safari in Nairobi, a routine proceeding which is as familiar to the general reader nowadays as its Swahili name, I proceeded by motor-car, and very easily covered the 150 miles in two days.

The only form in which the animal is at present known in England: A mounted specimen of a bongo (*Boocercus eurycerus*), four feet four inches high at the shoulder, in the Natural History Museum at South Kensington. Photograph by Courtesy of the British Museum (Natural History Department).

"I was fortunate enough to find an ideal site for my standing camp, seven thousand five hundred feet above sea-level, a most beautiful spot on the edge of the forest, with wonderful perspectives overlooking the game-haunted plains, which stretch away towards the snow-clad summit of Mount Kenya in the far distance.

"Now the bongo possesses this curious and almost human idiosyncrasy—that he intensely dislikes the perpetual drip from the sodden leaves on his coat during the rainy season, and tends, therefore at such times to come out into the more open country: it was on this trait that I had founded my hopes. But to succeed it was clearly essential that my preparation should be completed before the advent of the rains, and the construction of a solid log stockade, nearly 200 yards in circumference and nine feet in height, and that by the aid of raw native labour only, was clearly no light task. Incessant work, however, enabled me to complete it within two months, and, had the rains been normal, I should have had time sufficient for my purposes; but alas! these largely failed, and when I was ready for the bongo they had long since reverted to their haunts in the heart of the jungle; my labours were utterly wasted.

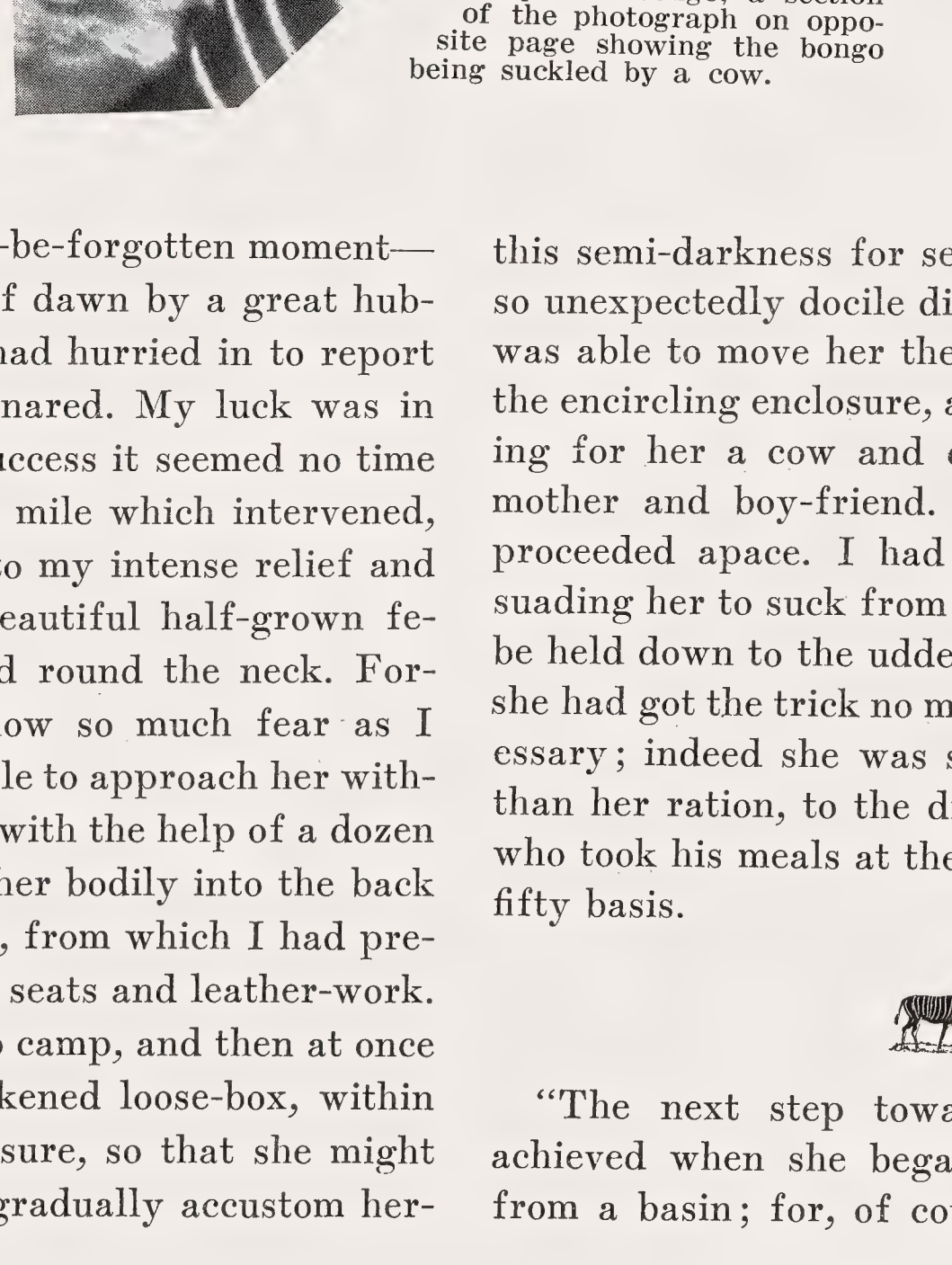
Mounted head of a male Bongo. National Collection of Heads and Horns, Zoological Park.

"There still remained however, the noosing of the game trails. Large stout posts were driven deep into the ground alongside the well-worn tracks, and to them I attached a stout rope. The end, looped and terminating

Colonel Percy-Smith's captive bongo, suckled by a cow simultaneously with a calf (whose fore-feet appear beneath the bongo's head), and trying to get "more than her fair ration": An interesting example of foster-motherhood.

in a slip knot, hung suspended tight in the fairway from small forked branches especially planted on either side, and the whole device was carefully concealed beneath cut bush and creepers.

"For this scheme the omens seemed slightly more favourable. True, I had never actually achieved success, but I had come within measurable distance of it several times. On one occasion a fine specimen had his head almost within the noose, when his eagle eye must have noticed the rope as of a slightly different tinge to the camouflage of creepers, and in an instant he was off; a vivid example, this, of the difficulties by which the hunter is perpetually confronted. Still I persevered; the most likely trails were daily beset, and duly visited the next morning by natives whom I had carefully trained.



"The unexpected thick ridge of hair running along the spine": Detail of this curious feature of the captured bongo, a section of the photograph on opposite page showing the bongo being suckled by a cow.

"At last—one never-to-be-forgotten moment—I was aroused at crack of dawn by a great hubbub in camp. The scout had hurried in to report that a bongo had been snared. My luck was in at last. In the thrill of success it seemed no time before I had covered the mile which intervened, and there, sure enough, to my intense relief and delight, I saw a most beautiful half-grown female bongo securely held round the neck. Fortunately, she did not show so much fear as I had anticipated; I was able to approach her without undue difficulty, and, with the help of a dozen natives, to rope and put her bodily into the back of my big 7-seater tourer, from which I had previously removed the back seats and leather-work. Thus we got her safely to camp, and then at once transferred her to a darkened loose-box, within a roomy stockaded enclosure, so that she might rest quietly awhile, and gradually accustom herself to the sight, sound, and smell of mankind.

"Now, at last, it seemed right to celebrate success with a few friends who had foregathered to offer congratulations. I had carefully kept, against such an occasion, a last bottle of champagne, thinking perhaps to break it over my capture for luck at the start of her new voyage in life. But when it came to the point I feared that it might alarm her, and, anyway, it would be a sinful waste of good liquor in the heart of Africa. So, though 'Doreen,' as I had decided to call her, was not formally christened, at least her health was well and truly drunk, with musical honours.

"I had expected to have to keep her in this semi-darkness for several days at least, but so unexpectedly docile did she prove to be that I was able to move her the very next day out into the encircling enclosure, and here she found waiting for her a cow and calf to serve as foster-mother and boy-friend. "Doreen's" education proceeded apace. I had some difficulty in persuading her to suck from the cow, and she had to be held down to the udders at the start, but once she had got the trick no more compulsion was necessary; indeed she was soon trying to get more than her ration, to the disadvantage of the calf, who took his meals at the same time on the fifty-fifty basis.

"The next step towards weaning her was achieved when she began to drink milk direct from a basin; for, of course, like all antelopes,

she was already accustomed from her earliest days to graze as well. She is now at a most attractive stage; has little fear of human beings, and will allow herself to be stroked and handled without difficulty.

"It is a perpetual interest to be able to study this most attractive creature at close quarters, with wonderful fidelity, and they clearly show what a bongo is really like at last.

"My story is only finished. Sooner or later will come the difficult journey by rail or car over the hundreds of miles that separate us from the coast. Next, the long sea journey must be faced, and lastly, saddest of all, the inevitable parting

"A beautiful and imposing creature", with brilliant chestnut coat and curiously striped transverse markings: The young female bongo, caught in the mountain forests of Kenya, and remarkably docile in captivity.

and to admire the gorgeous chestnut hue; the unexpected thick ridge of hair running along the spine—nature's protection and warning against the overhanging boughs of her natural haunts; and the white transverse stripings of the coat, all the more curious because, for some mysterious reason, there is one less on one side than on the other. But there, her fascinations have no end—at least, for me.

"Photographs can give no conception of the wonderful colouring; but her markings, shape, the curiously low carriage of her head, and the generally graceful appearance are reproduced when I leave her at her new home in some Zoological Gardens — Whipsnade, may be — who can tell?

"She, I am sure, will settle down in comfort and security, and be happy, free at last from the perpetual fear of attack by a pack of ruthless wild dogs or a prowling leopard. As for me, it will be a long time before I forget the enjoyable and interesting time spent in the 'Quest of the Bongo'."

Upon viewing Doreen head-on one is immediately impressed by the extraordinarily large ears. The slightest of strange noises never fails to gain their attention as they immediately turn toward the source of the sound. In their native forests, bongos undoubtedly rely largely upon their keen sense of hearing to tell them of impending danger.

The Bongo Comes to the Zoological Park

CLAUDE W. LEISTER

Illustrations from Photographs Made in the Zoological Park in April by E. R. Osterndorff.

THE New York Zoological Society has ever been in the field to secure specimens of animal life that ordinarily, because of their rarity and the inaccessibility of their homeland, are seldom seen in Zoological collections. The director of every zoological park or garden always has lists of animals which he hopes sometime to exhibit; animals that never before have been seen in captivity. The bongo, one of the most striking of all antelopes, and a native of the dense mountain forests of Africa, has had a prominent place on all the lists of greatly desired specimens.

Knowing that Col. Percy-Smith was going into bongo country in the Aberdare mountains of Kenya Colony, and that he might possibly capture one of these rare animals, Dr. Blair immediately communicated with him and made a tentative offer for a bongo to be delivered alive in New York. Fortunately, as readers of these pages already know, Col. Percy-Smith's venture was successful, and on June 6, 1932, he captured a young female bongo. Negotiations for her purchase were continued, and "Doreen", as she had been named, was finally acquired by Dr. Blair for the Society.

Few persons are aware of the many difficulties that attend the transportation of a wild animal from Africa to the United States, especially one of unknown disposition and traveling ability, and the following, very brief, account of Doreen's journey may be of interest to all those who at times have wondered how animals are brought to the Zoo.

To prepare Doreen for the journey, it was first necessary that she be weaned and accustomed to a dry grain and hay diet. This was successfully accomplished and when about eleven months old she was ready to travel and in perfect physical condition, due in particular to the great pains taken by Col. Percy-Smith in arranging for and anticipating every detail con-

cerning her needs. Finally everything was in readiness for the actual start of the trip. Doreen was placed in quarantine for a month and granted a certificate of health, certifying that she was "disease free and without injury". She was taken safely to the coast (Mombasa), part way by motor truck and part way by rail.

Here arrangements were completed for the ocean trip to New York. Doreen was installed in a comfortable shipping crate, furnished with enough food to last for the trip, and accompanied by detailed feeding instructions and a quantity of milk of magnesia for possible indisposition.

Thus equipped, on November 26, 1932, she was loaded on the *S. S. Durham Castle,* bound for London. Captain and crew were so keenly interested in the venture that she was more than well taken care of, even to the extent that suitable awnings were erected to protect her from sun and weather. The *Durham Castle* arrived in London on December 22, 1932 and Doreen was transhipped to the *S. S. American Banker,* leaving for the United States the following day. Dr. Blair boarded the *American Banker* at Boston and accompanied Doreen to New York, where she was quickly unloaded and taken in a comfortable van to the Zoological Park.

She survived her long journey in perfect condition, accepted her roomy quarters in the Antelope House without fuss or bother and at once seemed to make herself at home. At this writing she continues in good health, has grown appreciably, and now enjoys the sunny days of spring in her corral. Doreen is a lovely animal and we hope that she may stay with us for many years to come.

The white lateral stripes of the bongo are frequently unequally produced on opposite sides of the animal. Doreen possesses this characteristic, having twelve stripes on the right side (*top*), and eleven on the left (*bottom*). The last short stripe at the base of the tail does not show in the lower photograph. Other white markings may vary in size and shape, and old bongo bulls, instead of being red, the usual color, are almost black.

Map of Africa showing the distribution of the races of the bongo, which is indicated by the darkened areas marked respectively 1, 2 and 3. Area 1, *Boocercus eurycerus eurycerus;* Area 2, *Boocercus eurycerus isaaci;* Area 3, The General locality marking the habitat of two other races, *Boocercus eurycerus katanganus* and *Boocercus eurycerus cooperi.* Doreen was captured in the Aberdare Mountains of area 2. Map prepared under the direction of Dr. Blair by the Engineering Department.

Doreen, in a characteristic attitude, photographed in her corral at the Zoological Park. The dorsal ridge of hair, or mane, running the full length of the back, shows to advantage in this photograph. It will be noted that the white lateral stripes are carried across this mane and marked by white tufts of hair. The white markings on the legs and white collar on the lower neck are typical of the bongo.

The two upper portraits of Doreen show her large intelligent eyes and general appearance of docility, and in addition the white facial markings characteristic of the bongo. In the lower photograph the unsymmetrical arrangement of the stripes can readily be seen and it will be noted that the sixth stripe on the left side is missing. The prominent ridge of hair on the back is also seen to advantage.

The Harnessed Antelopes and Their Allies

Raymond L. Ditmars
Curator of Mammals and Reptiles, Zoological Park
Illustrations from photographs made in the Zoological Park.

AFRICA, south of the Sahara, has the greatest variety of hoofed animals of any area in the world. From the southerly border of the great desert, to the Cape, this life is also characteristic in form, embracing an impressive number of species of antelopes. Africa practically represents the sole locality of these animals, as only a few species are found outside the continent, and they are confined to a small area of Asia. Another peculiarity about the hoofed animals of Africa is the absence of any species of deer throughout the vast antelope domain.

As is natural with an array of animals like the antelopes, several groupings are indicated, and these have been scientifically accorded separation into subfamilies. This article relates to one of these subfamilies, the *Tragelaphinae,* with but a moderate number of species, but of particular interest because of unique markings, and the large size of several of the members.

From the viewpoint of the collector of trophies, the harnessed antelopes are commonly known as bushbucks, and are grouped as five species. They are recognized by white, ring-like markings circling the body. Technically, there are six additional species, some with ringed markings. Two of the species occur in India.*

From the standpoint of etymology, the harnessed antelopes are poorly named. To call them ringed antelopes would seem more fitting, owing to their encircling markings. It is true that one species, the bushbuck or guib, *Tragelaphus scriptus scriptus*) has both ringed and longitudinal markings, in form as if the animal were encased in harness. As it precedes the others in some of the technical lists, and as its markings are really harness-like, while the related species are similar to it in their transverse striping, the common title for the group probably came into being from this condition. The ring-like markings of the various species vary in number among individuals, and with some examples are no more than transverse stripes, separated by the vertebral ridge, and may even differ in number on either side of an animal. Among specimens of several kinds exhibited in the Park, we have noted a curious tendency toward one or two lesser number of rings on the left side of the body. Of the entire grouping, the Society has exhibited the bongo, sitatunga, greater kudu, eland and nylghai, all of which are now living in the Park's collection, with the exception of the sitatunga.

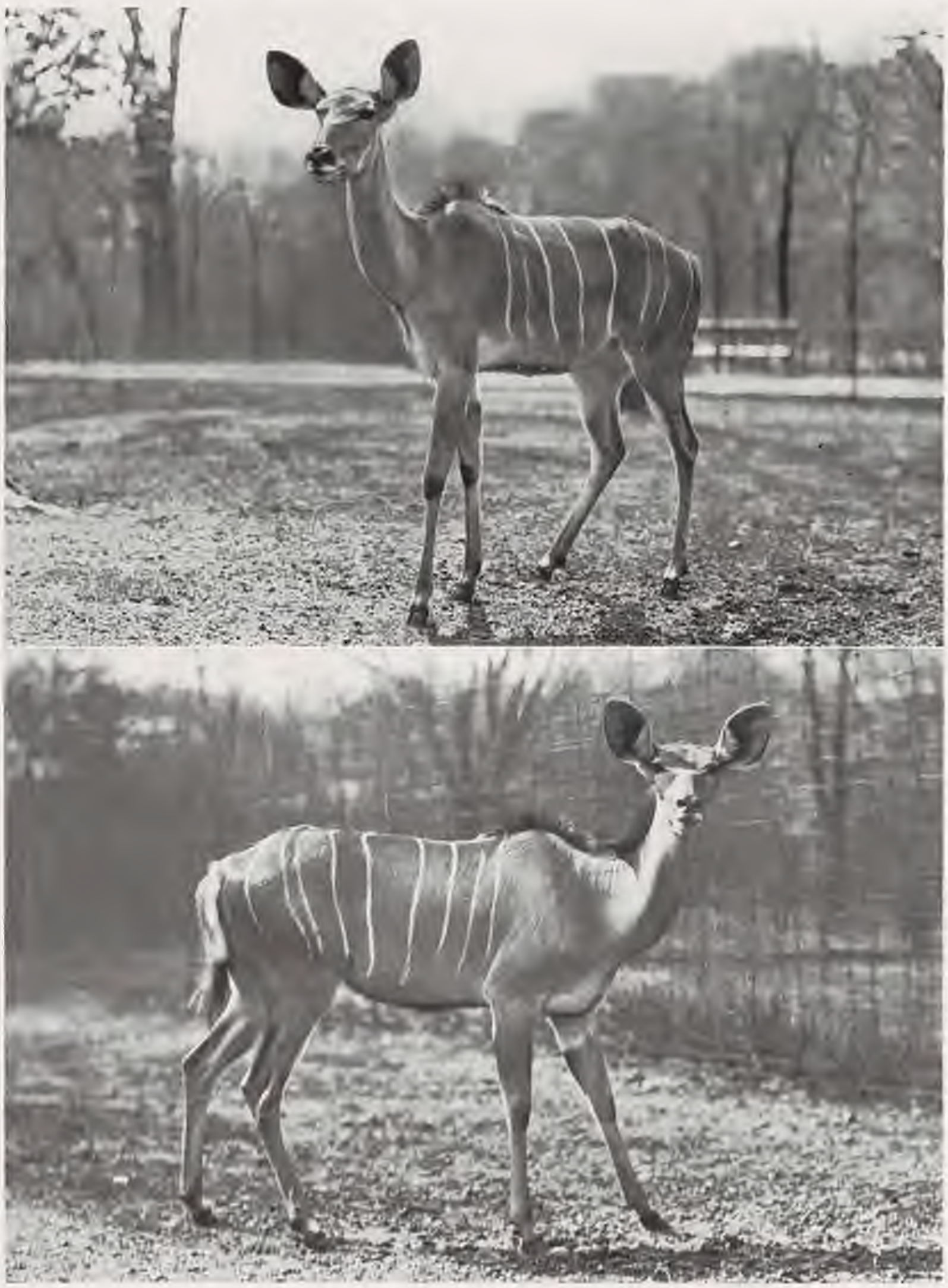
With the greater number of the species of this group, only the male members have horns. These are slightly ridged and spirally twisted upward and outward. With some of the species, the horns are rather short and stout. With the bongos and the elands, the females are also horned, those of the latter species practically as long-horned as the males. The proportionately longest horns among all the species are possessed by the greater kudu. With this animal, the horns sweep upward in flaring spirals.

By far the largest of the antelopes with ring-like markings, are the elands, which are also the largest antelopes of Africa. The more common species, inhabiting southerly Africa, is a truly impressive animal, attaining a weight up to 1500 pounds among adult males. Large females, however, seldom exceed 1100 pounds. Body hue of individuals varies from blue-gray to tan or reddish. A large example recorded by Lydekker stood five feet, nine inches at the withers. The average length of horns is about two feet, although they have been recorded up to thirty inches. Adult specimens, as a rule, show little or no striping, but the stripes are vividly marked on immature individuals and are retained longest on female examples. Specimens in the northerly portion of the range—in the vicinity of the Zambesi—show the greater tendency to retain the stripes into maturity.

With its fine build, extremely long and spirally sweeping horns, and attractive markings, the greater kudu, inhabiting a large part of Africa south of the Sahara, is the handsomest of the *Tragelaphinae.* It is long-bodied, slender-limbed and high-headed, rather like a large deer in outline and actions. The neck is maned, and

*The inconsistency of "popular" names is indicated in the listing of bushbucks, which, separately, are as commonly known under other titles. See page 45.

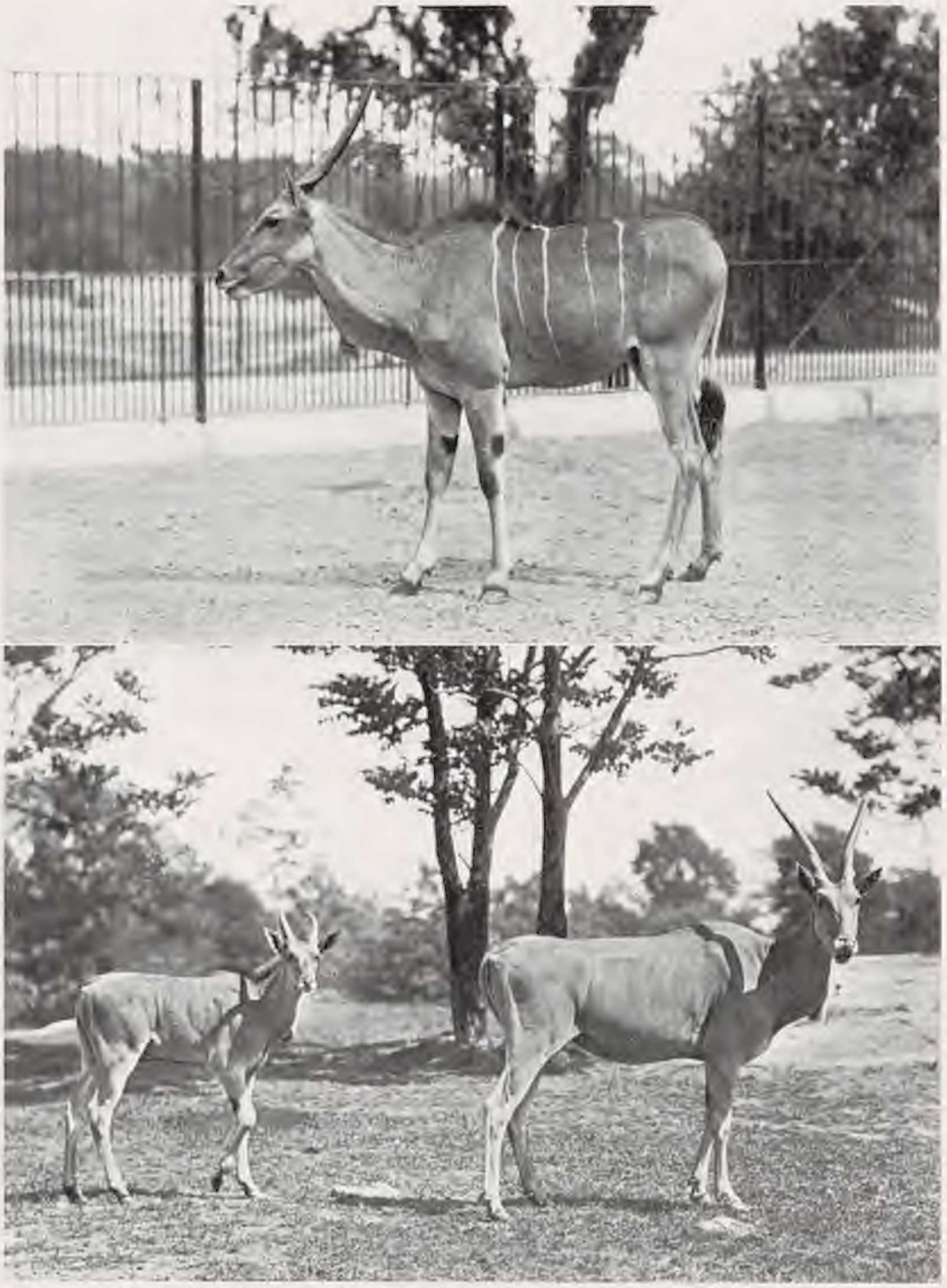
Greater Kudu, *Strepsiceros strepsiceros*. (Adult male). Ranging from the Cape to the central portion of Africa, the kudu is among the largest and handsomest of the many and varied antelopes of that country. A good pair of horns will measure slightly over five feet along the curve.



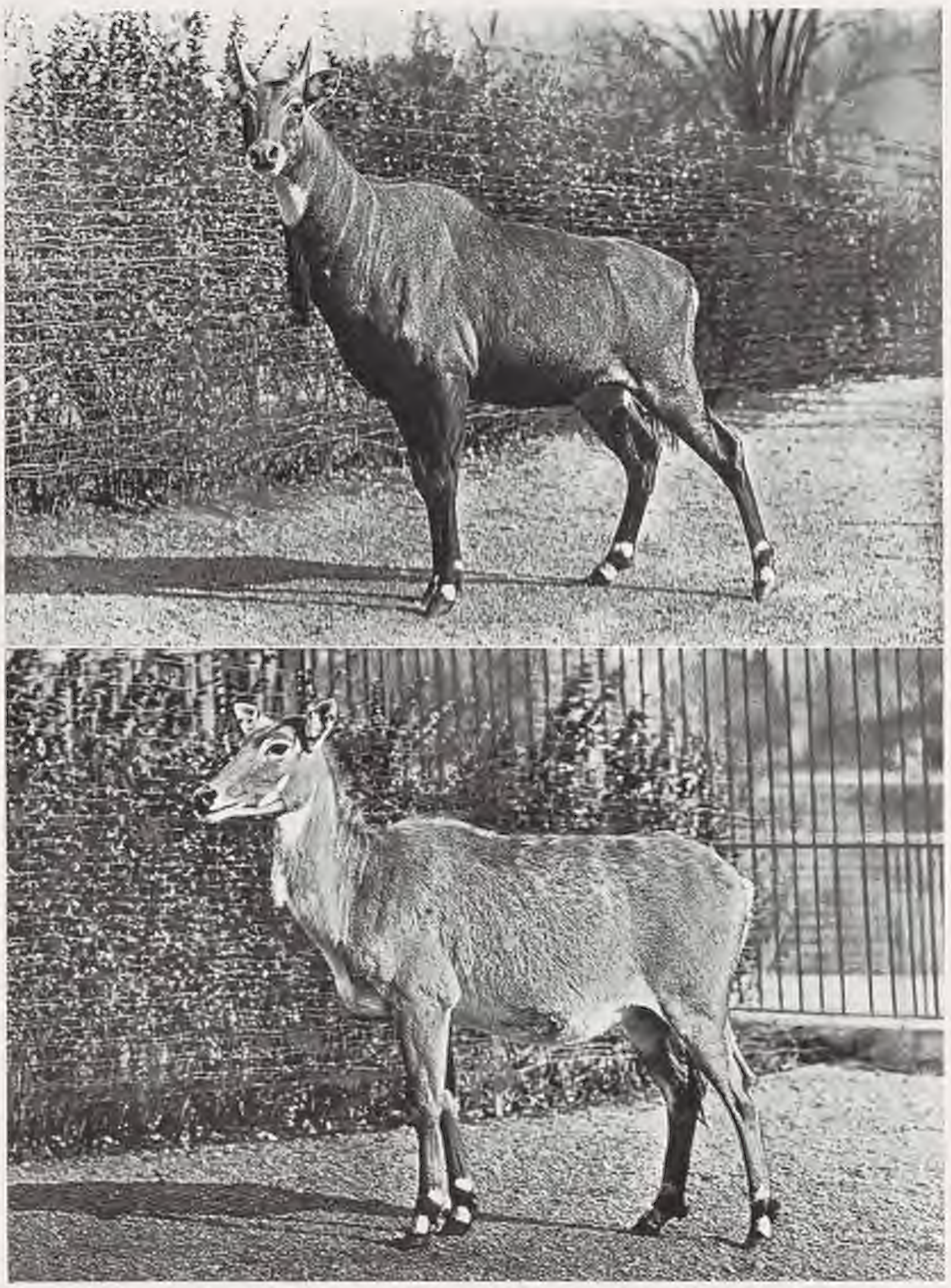
Greater Kudu, *Strepsiceros strepsiceros*. Adult female, showing opposite sides. There is a tendency, among the ringed or "harnessed" antelopes, for the stripes to vary in number on opposite sides. It can be noted in these illustrations that the right side of the animal has the greater number of white markings.

Greater Kudu, *Strepsiceros strepsiceros*. *Upper*: Mother and young a few days old. *Lower*: Calf figuring in upper scene. Among a fair number of the antelopes, the females are quite hornless. Both horned and hornless females, however, occur in the subfamily containing the ringed or "harnessed" antelopes.

Eland, *Taurotragus oryx*. An adult male, in his prime, and impressively illustrating the massive build of this species, which is the largest of all antelopes. It attains a height at the withers of over five and one-half feet, and a weight in excess of 1500 pounds.



Eland. *Taurotragus oryx*. *Upper*: Striped female, of northerly race. *Lower*: Female, without stripes, and young. As with the greater number of the species of antelopes, both the male and female eland have horns, although with the latter, the horns are lighter and shorter. The striped, northerly race is designated by the subspecific title of *livingstonei*.



Nylghai. *Boselaphus tragocamelus*. *Upper*: Adult male. *Lower*: Adult female. The nylghai is the largest of the comparatively few species of Asiatic antelope. Its distribution embraces a considerable portion of India, although it does not occur in Ceylon. It is related to the harnessed antelopes, but lacks ringlike markings. The indicated stripes on the neck of the animal in the upper picture are actually folds of the skin.

the throat usually furnished, in maturity, with a fringe of long hair. The female is hornless. Accompanying illustrations show male, female and young of this species, and indicate the variation of the ring-like markings among individuals. Length is about eight feet. The horns range in length from forty to fifty inches in a straight line, and to slightly over seventy inches along the curve. A large male weighed 705 pounds. Ring markings usually remain well defined on the adults.

Bringing together the grouping popularly known as harnessed antelopes or bushbucks, we note animals of smaller size, although two of the species, the bongo and nyala (also known as inyala), are approximately within a foot the height of the kudu. These two kinds are also the most vividly ringed and the rarest in captivity.

So far as we are aware, the only specimen of the nyala,*Tragelaphus angasi* (of easterly Africa) to be exhibited alive, is now in the collection of the National Zoological Park, at Washington, D. C., and the only captive example of the bongo, *Boöcercus eurycerus isaaci* (also of easterly Africa), is now in the collection of the New York Zoological Park. One reason for the difficulty in obtaining these species is the character of their *habitat*. They frequent dense forests, during the day hiding in what to humans would be impenetrable places, and are said to come from such tangles at night, to feed. The character of the country which they inhabit is described in detail, in an accompanying article.

The other species of bushbucks, some of the better-known sub-species of which are indicated in the list included in this article, have been exhibited in various zoological gardens. They are smaller and more slender than the bongo and nyala, and one of them, the sitatunga, particularly so. It inhabits the swamps of central, south central and eastern Africa, and the development of the feet, in elongation of the hoofs, shows specialization for traversing soft places. The horns of male sitatungas—the females are hornless — measure on an average of twenty inches in a straight line. A record pair shows a measurement of twenty-seven inches.

Subfamily *Tragelaphinae* Harnessed Antelopes or Bushbucks

Bushbuck (*Tragelaphus scriptus*)

- West African Bushbuck (*Tragelaphus scriptus scriptus.*) Bright rufous; stripes very conspicuous. West, Central and South Central Africa.
- Abyssinian Bushbuck (*Tragelaphus scriptus decula*). Rather short-legged and heavy-bodied; the stripes are indistinct. Abyssinia and Somaliland.
- Cape Bushbuck (*Tragelaphus scriptus sylvaticus*). Dark brown, with no transverse stripes. Cape Colony.

Mountain Bushbuck. (*Tragelaphus buxtoni*). Sahatu Mts. of northwestern Gallaland to Lake Zwai.

Nyala (*Tragelaphus angasi*). Nyassaland, Delagoa Bay, Zululand.

Sitatunga (*Limnotragus spekei*). Semi-aquatic, inhabiting dense swamps. Elongated hoofs.

- Eastern Sitatunga (*Limnotragus spekei spekei*). Uganda and the Sudan.
- Zambesi Sitatunga (*Limnotragus spekei selousi*). South Central Africa.
- Western Sitatunga (*Limnotragus spekei gratus*). The Congo, Gabun, Nigeria.

Bongo (*Boöcercus eurycerus*)

- West African Bongo (*Boöcercus eurycerus eurycerus*). West Africa: Liberia, Gabun, to Uganda.
- East African Bongo (*Boöcercus eurycerus isaaci*). Kenya Colony.
- Uele Bongo (*Boöcercus eurycerus cooperi*). Belgian Congo.

Related Species

Greater Kudu (*Strepsiceros strepsiceros*). Several races. Greater part of Africa, south of Sahara.

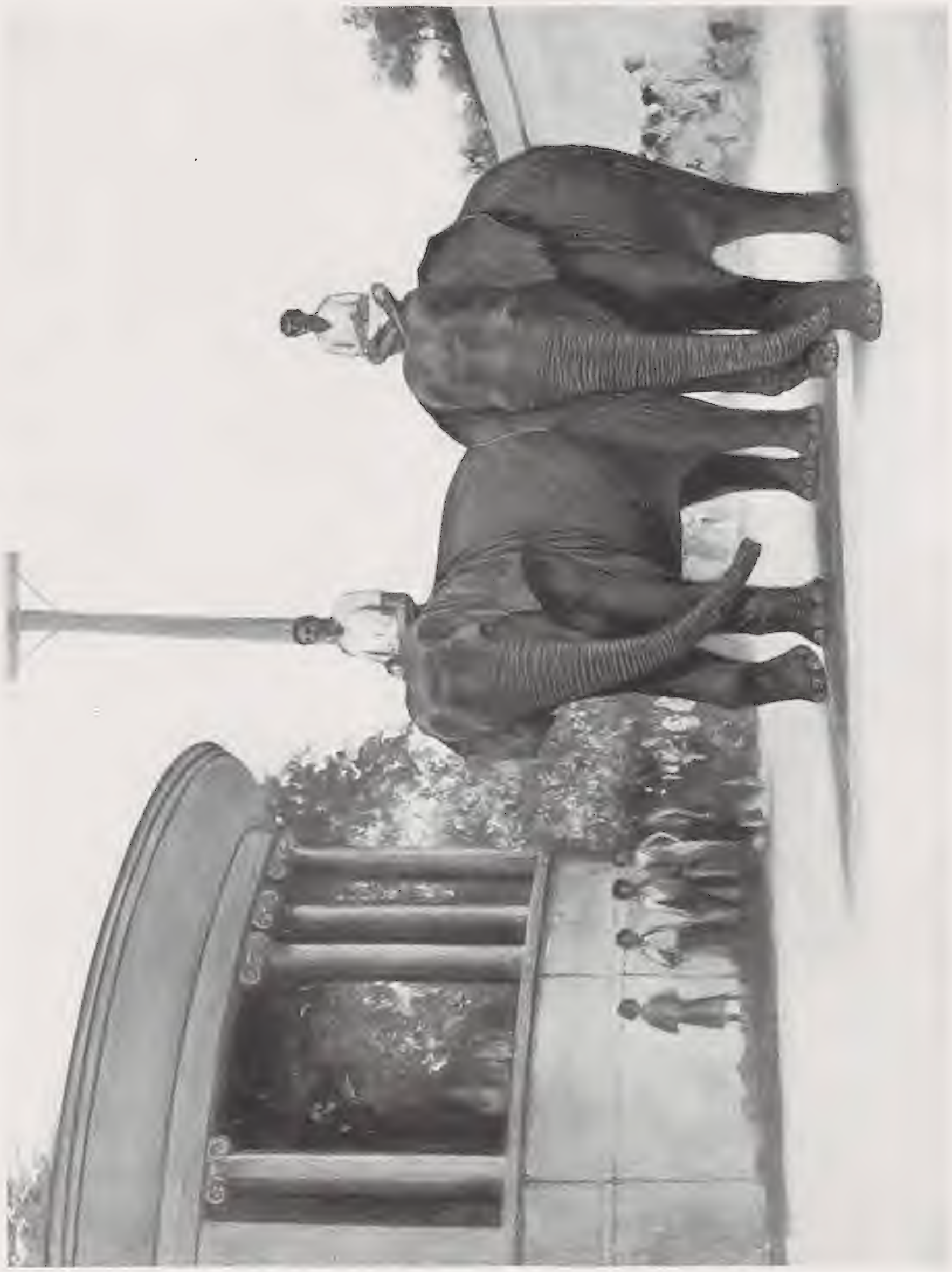
Lesser Kudu (*Strepsiceros imberbis*). Southern Abyssinia, Somaliland to Kenya and Tanganyika.

Eland (*Taurotragus oryx*). Zambesi to the Cape.

Derby Eland (*Taurotragus derbianus*). Senegambia, Gambia, the Guineas and Upper Congo.

Nylghai (*Boselaphus tragocamelus*). India.

Four-horned Antelope (*Tetraceros quadricornis*). India.



Two of the elephants which were employed by trainers and keepers in an endeavor to capture Siri Nan, one of the two Royal elephants that ran "amok."

Tragedy Among Royal Pachyderms in Siam

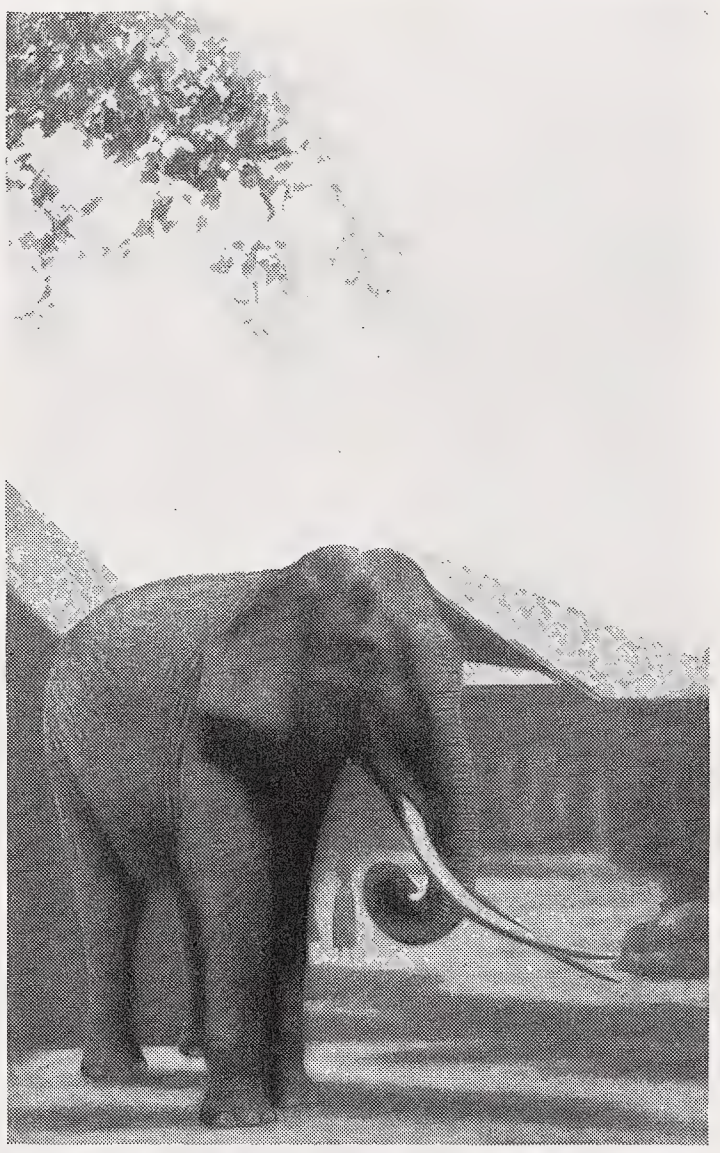
Being an account of the death of two tuskers in the Royal Elephant Stables in Bangkok under most unusual circumstances.

Dr. Edwin B. McDaniel

The illustrations for this article, with the exception of the head and tail piece, were resurrected from cuts in the Bangkok (Siam) *Daily Mail.*

"THONG KHAM is crazy again" was the cry on every tongue as excited crowds ran panting toward the elephant stables in Siam's capital city. More or less they were used to the pranks of this elephant as he went back and forth to his daily bath.

For nearly a week now he had been growing worse, until his great rage finally became so overpowering that early one afternoon of that fateful week, he gave a mightier heave than ever and snap went the great chain that had held him captive. He was in an ugly fighting mood. Nearest him was a somewhat smaller tusker, the "Pride of Nan." He would pick a quarrel with him. Covering the few yards between them he struck the unsuspecting beast amidships with his great tusks. Backing away he prepared for another rush.



Siri Nan, before his fall posing unconsciously for the photographer who risked his life to get a picture of the mad elephant.

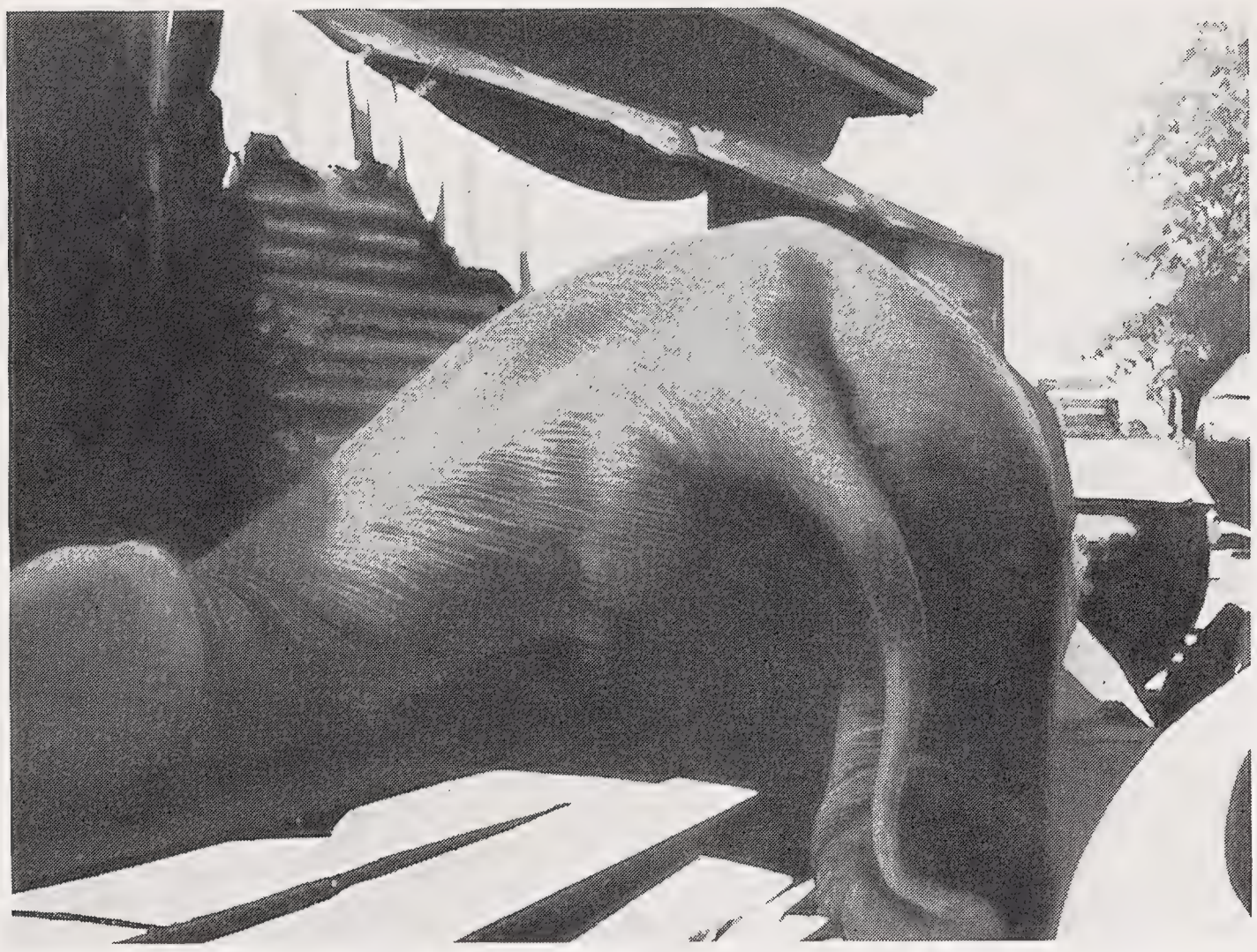
Now he had for some time been picking on his smaller stable-mate as they went together to their bath. Usually "Nan" had shown fear, but for some reason today he showed fight and naturally this increased the wrath of the burly aggressor.

For a moment it was "give and take" with the keepers rushing in to stop the conflict. And then another chain snapped and "Siri Nan," who had already enough, turned tail and sought the open road. The aggressor tried to follow but the keepers had been reinforced and for the moment he was prevented from doing so.

Siri Nan was free! It was a novel experience for him to be out on the street without that dark bunch perched on his neck and directing his every move. It reminded him of the days before his capture when he ran with the herd away up beyond Chiengmai. He hoped it might continue though he didn't like the wild shouts of so many people. And where was Thong Kham?

A great many Government offices are in this vicinity so Siri Nan made their rounds. Trumpeting shrilly he raised his trunk in seeming salute to the High Officials and humble clerks who in answer to his trumpeting now filled all the windows. Work for them was not to be thought of, but they were glad they were inside and not outside with him.

Like magic the crowd grew. Such a spectacle as this was unusual and one could shout as well. The keepers who had trailed their charge were shouting, why should they not lend a friendly mouth also. And so the noise grew until Siri Nan became thoroughly fright-



Siri Nan, shown in the position which led to his untimely death, when he fell into the river.

ened. He thought only of his stable with its great bundles of green fodder waiting for him there and, best of all, the quiet. But the crowd hemmed him in on every side except toward the river. He would go there.

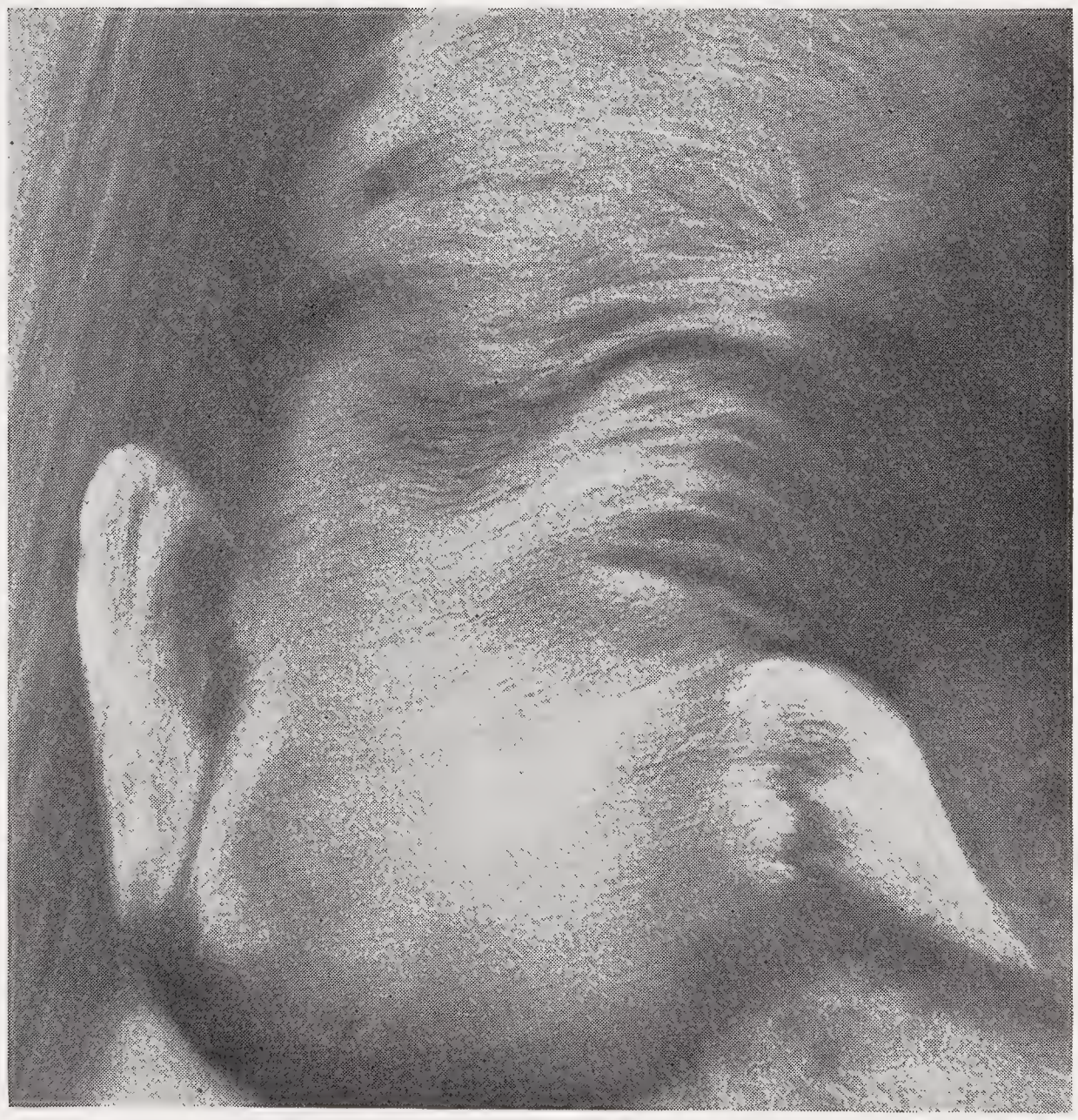
At this juncture the head keeper of the elephants appeared on the scene with two other tuskers, hoping to entice Nan back to his stall. Nan's ribs were aching where Thong Kham had rammed him and he was watching for his enemy out of the corner of his eye. Unfortunately he mistook one of these new comers for his late oppressor and bolted again.

Halting not far from the river bank, he faced it, evidently considering it as a possible avenue of escape from all this turmoil. In front of him was this broad expanse of water, behind and on all sides the curious, noisy, growing multitude.

Growing bolder, and pushed forward by the mass of humanity behind them, the crowd came nearer and nearer. Sensing this possible danger, Siri Nan wheeled suddenly and trumpeting loudly made as though to charge right into the thick of the crowd, but held his place. Time and again he went through these threatening maneuvers, the crowd giving way to flight each time. With angry shakes of his great head, rapidly fanning ears and nervous pawing of the earth with his big feet, he faced them all.

They were not the folks he knew—not the inoffensive creatures he had so often seen calmly crouched by the roadside as he had moved majestically along in great State Processions. *Then* he carried a beautifully inlaid howdah on his back and was resplendent with trappings of silver and gold.

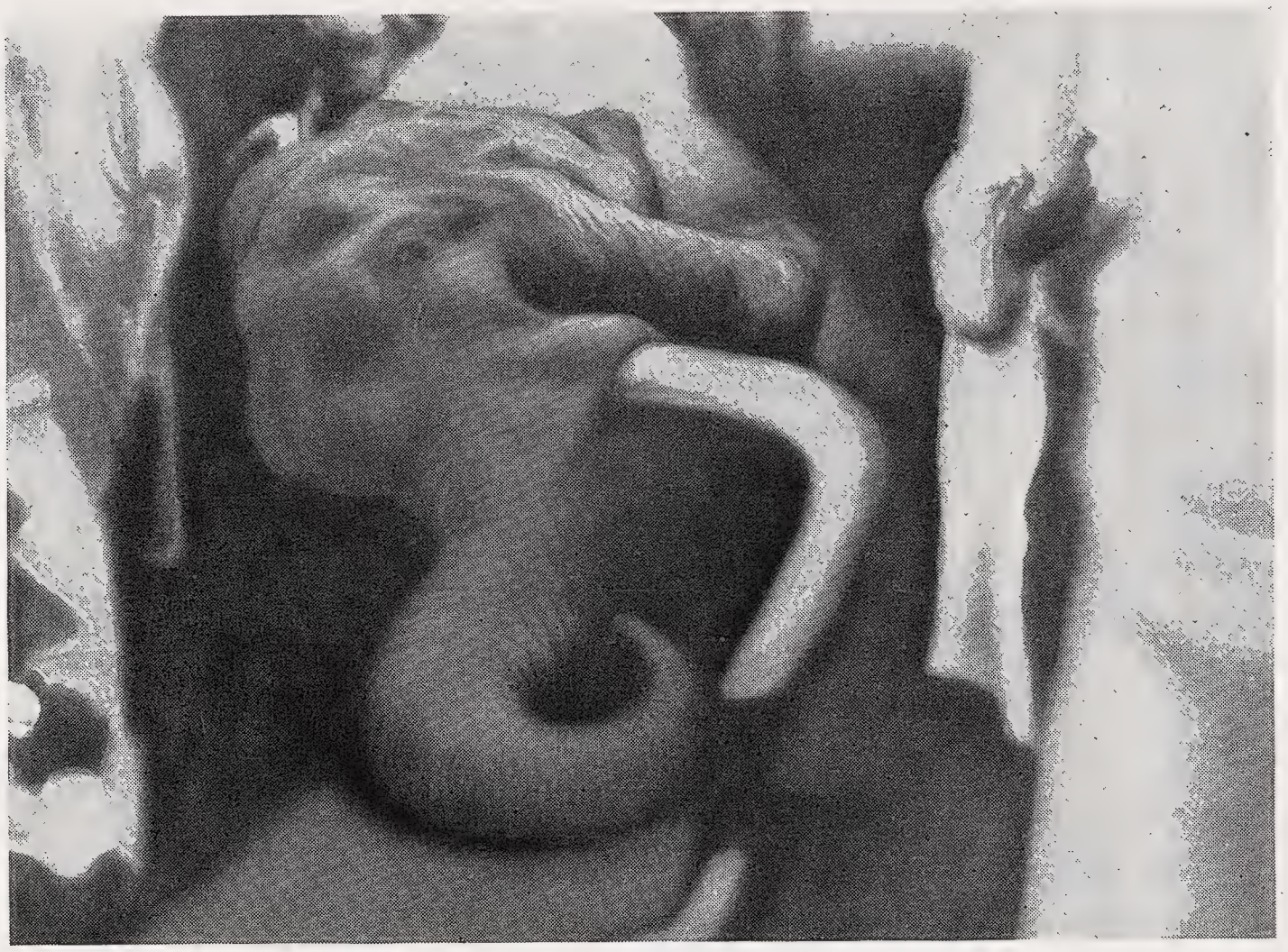
These creatures struck terror into his heart. They must be enemies and they were far too many for him to fight. He must flee. He would



Siri Nan with his head in the water and unable to move, following his fall into the Menam Chao Phya in front of the Rajini Girls' School.

plunge into the river which was always friendly to him. Did he not bathe in it every day and did he not always return refreshed?

A short and frail bridge led to a boat house landing. It was only a step. Under normal circumstances he, sharing the wisdom of his kind, would not have ventured upon so frail a structure. But things were not normal; most decidedly they were not, and he had grown desperate. He ventured, and just as he set foot on the narrow landing it collapsed, throwing him head first into the shallow water and imbedding both tusks in the stiff mud of the river bank. His head was thus literally pinned beneath the muddy water. His huge body moreover was jammed tightly between many large piles deeply sunk into the river bed to anchor the nearby boat houses. The impact was terrific.

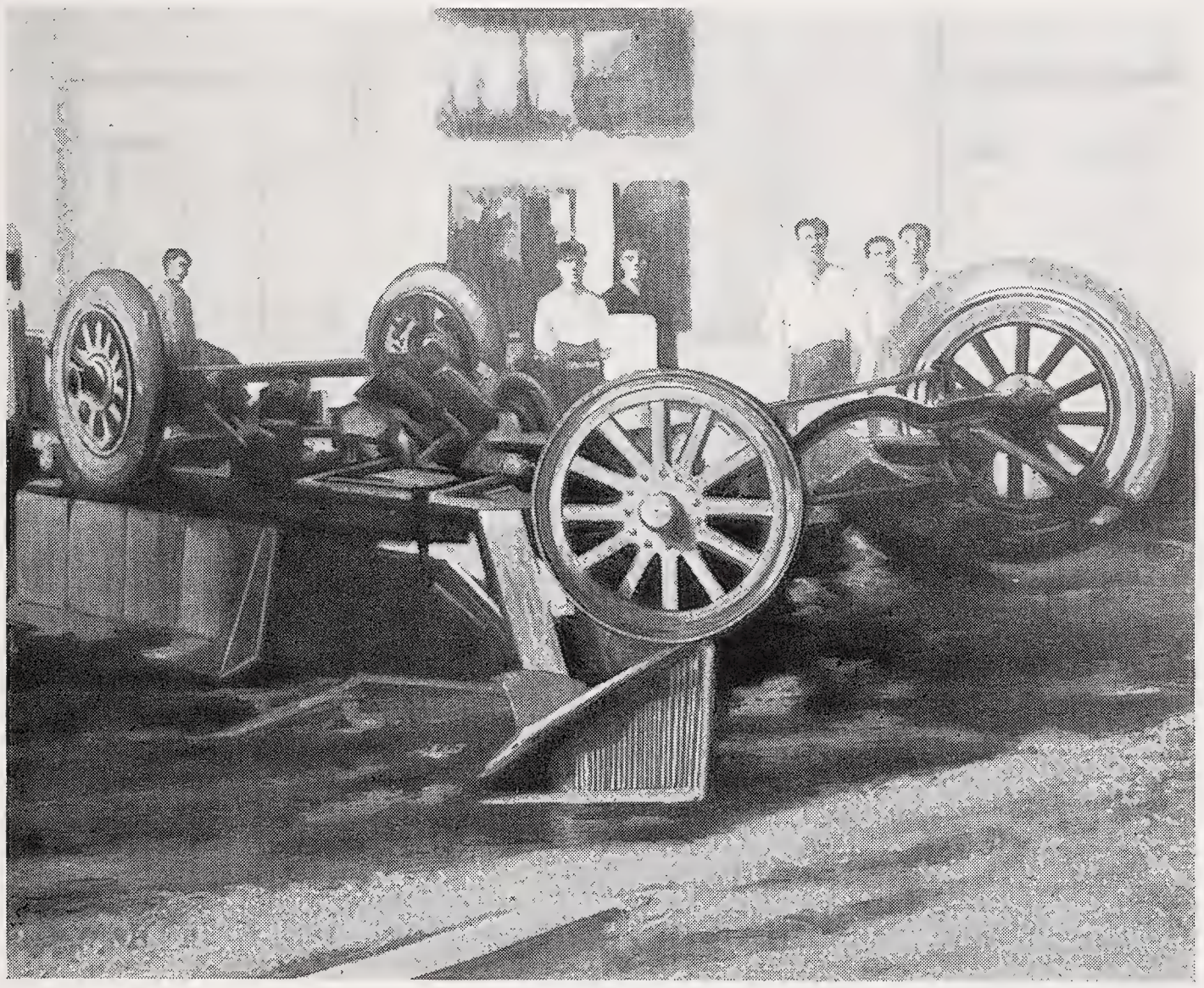


Thong Kham, dead, in front of his corral after orders had been issued to poison the elephant if he proved uncapturable, following his trampling to death of Nai Jum.

The poor beast screamed with pain and terror. He tried with mighty struggles to free himself. But with his head pinned to the river bed, his movements cramped by the piles, he could not use his mighty strength to free himself. As it was he snapped off several of the big posts. The occupants of the house, gathering their babies, fled in terror.

Whatever was to be done to rescue him must be done quickly. A long hawser was procured and divers placed it around his hind quarters. A hundred willing hands pulled mightily and long, again and again. A motor car was hitched on to help. Other elephants lent their strength, but it was no use. Only a crane or derrick of great lifting power could have saved him and neither was at hand.

He was caught in as cruel a trap as any enemy could possibly have devised. Perfectly at home in the water, yet he was, under these pathetic circum-



What happened to a motor car in front of the Ministry of Justice which stood in the way of Thong Kham, after he had broken loose for the second time.

stances, literally drowned and his cries grew weaker, his frantic struggles soon ceased. This was death number one.

But what has the "musth"* beast been doing all this time? Rushing past his keepers, he too took to the open road and while only a moment behind Siri Nan he fortunately took a different direction, but *he* was bent on mischief.

An inoffensive old man, perhaps a little deaf, did not hear his approach and was speedily knocked down and trampled to death.

A motor truck was the next object of his fury. It had only just arrived loaded with soldiers to assist in his capture. Seeing the fate of the old man they took to their heels. Thong Kham pushed and dragged the truck a hundred feet or more and then turned it upside down as easily as though it had been an empty packing case. He was on a rampage and having a great time!

Apparently growing tired of this sport he ambled back to the stable grounds where for two hours he amused himself by knocking the keepers' houses to pieces.

One man offered to capture him for ticals three hundred ($150 Gold) provided he was furnished with two elephants larger than Thong Kham. But no elephants of such size being available his offer was not accepted.

The authorities therefore, in order to avoid the probable loss of more lives, decided that the outlaw should be poisoned. Liberal doses of strychnine were put in bananas and the task of feeding them to the elephant fell to his old keeper. His eyes streaming with tears, his frame shaken by sobs, he fed them to him one by one. Despite Thong Kham's wickedness, the keeper still loved him. Soon the powerful poison took effect and death came to end the danger.

Thus perished in the short space of a single day these two splendid Royal tuskers and under circumstances tragic in the extreme.

Thong Kham was twenty-eight years of age, eight and one-half feet high and bore tusks five feet long. When not in "musth" he was very docile and, like Siri Nan, had taken part in many State processions.

Siri Nan was a smaller animal and his ivory was somewhat lighter.

After nightfall the two carcasses were towed by boat to the elephant burying ground far below the city. Perhaps never before had this great river borne on its waters at the same time the huge bulk of two such victims with ends so pitifully tragic.

No more sugar cane from the hands of admirers. No more gorgeous howdahs and cloth of gold. No more pride in carrying Royalty in great State Processions.

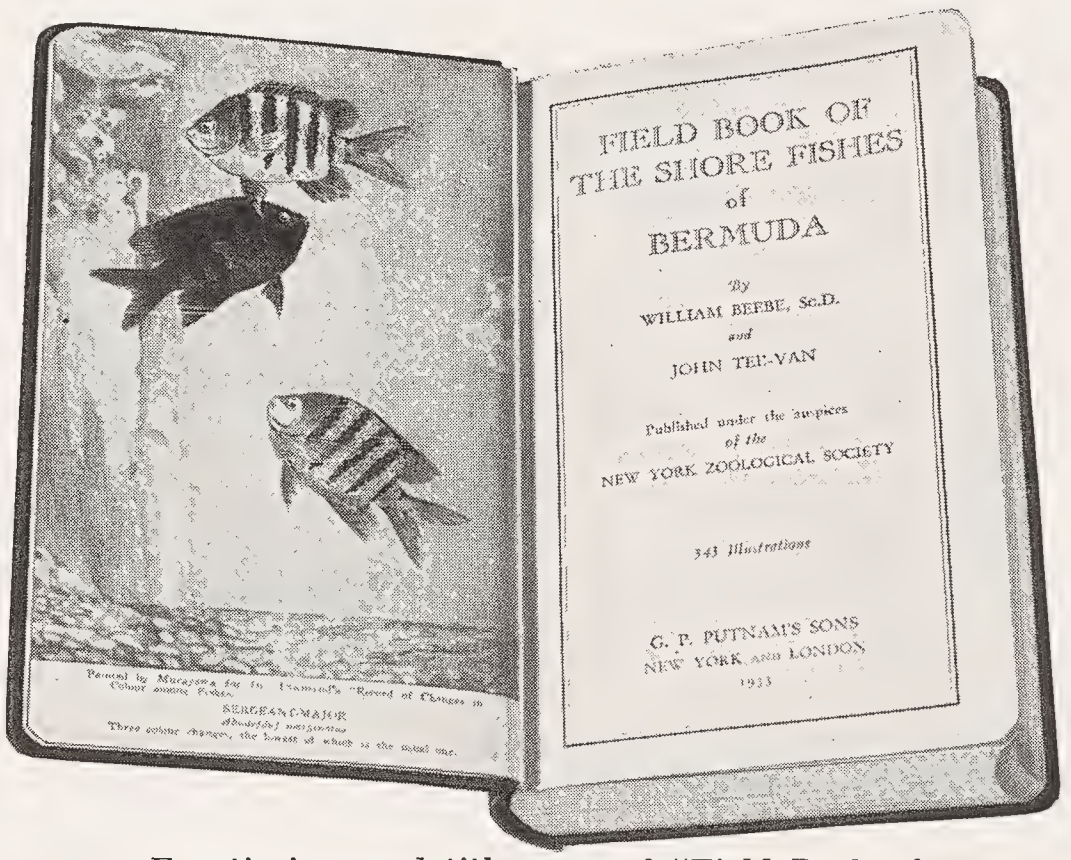
It is of interest to learn that, according to regulations, there must be delivered to the Elephant Department the tusks, the bones of the front and hind legs, the toe nails and the tips of the trunks as proofs of disposal.

* Male elephants on attaining maturity are subject to peculiar periodic paroxysms of excitement, to which the name "musth" is applied by the natives of India. This condition undoubtedly has some connection with the sexual function and is probably analogous to the rut in Wapiti and certain other species of deer.—W. R. B.

"Field Book of the Shore Fishes — of Bermuda"

By William Beebe *and* John Tee-Van

AS the title indicates, this volume presents a concise, but at the same time inclusive, outline of fishes found off the shores of Bermuda. It is practically a general introduction to the further and more detailed study of many of the Bermuda and West Indian fishes, whose life histories are as yet incomplete. According to the authors, so far not one complete life history of a Bermuda fish is known. The book accomplishes a useful purpose in that it contains within a limited space a great quantity of needed and little known information concerning the fish life of the waters surrounding the Bermudas.



Frontispiece and title page of "Field Book of the Shore Fishes of Bermuda."

The material presented in the volume is based upon the results of four years of work by the staff of the Tropical Research Department of the New York Zoological Society on Nonsuch Island and Bermuda, as well as the laboratory studies continued in New York in the intervals between field expeditions. This research included also comparative studies of West Indian and Bermuda fishes found in the collections of various museums in the United States.

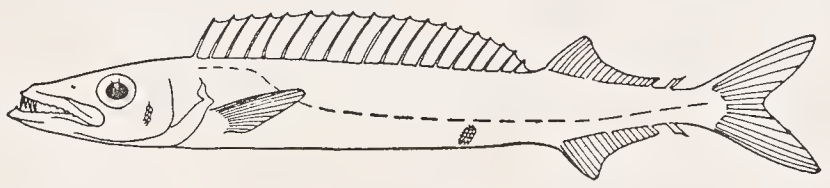
The main text of the book is prefaced by an introduction which contains a brief statement concerning fishes in general, — answering such questions as "What is a fish?" and among other things telling about their numbers, distribution, migrations, their size and weight (always an important consideration with fishermen), coloration, teeth, food, poison glands, courtship, nests and eggs, and their psychology,—since this timely topic appears to have invaded even the field of ichthyology.

It is interesting to find, in connection with the origin of Bermuda fish fauna, that approximately seventy-five per cent comes from the West Indian islands, nine per cent of which is found only in the waters adjacent to the island of Bermuda, while the remaining twenty-five per cent are pelagic, with world-wide distribution near shore or with distributions including the eastern Atlantic and the eastern Pacific Oceans.

The manual describes 335 species of fish, these representing the shore fishes and the more common pelagic forms about the island, such as dolphins and flying fish. Each species is illustrated by an outline drawing, accompanied by data giving field characters, diagnosis and distribution. In addition the volume contains four colored plates, sixteen pages of photographs, and numerous maps and diagrams, all of which enable the reader to obtain a very clear and accurate idea of the identity of these various fishes. As an aid to the student of ichthyology and the field worker, the book contains complete keys for the determination of species, as well as a bibliography of the more important works on Bermuda fishes. An index for ready reference appears at the close.

Bermuda Catfish

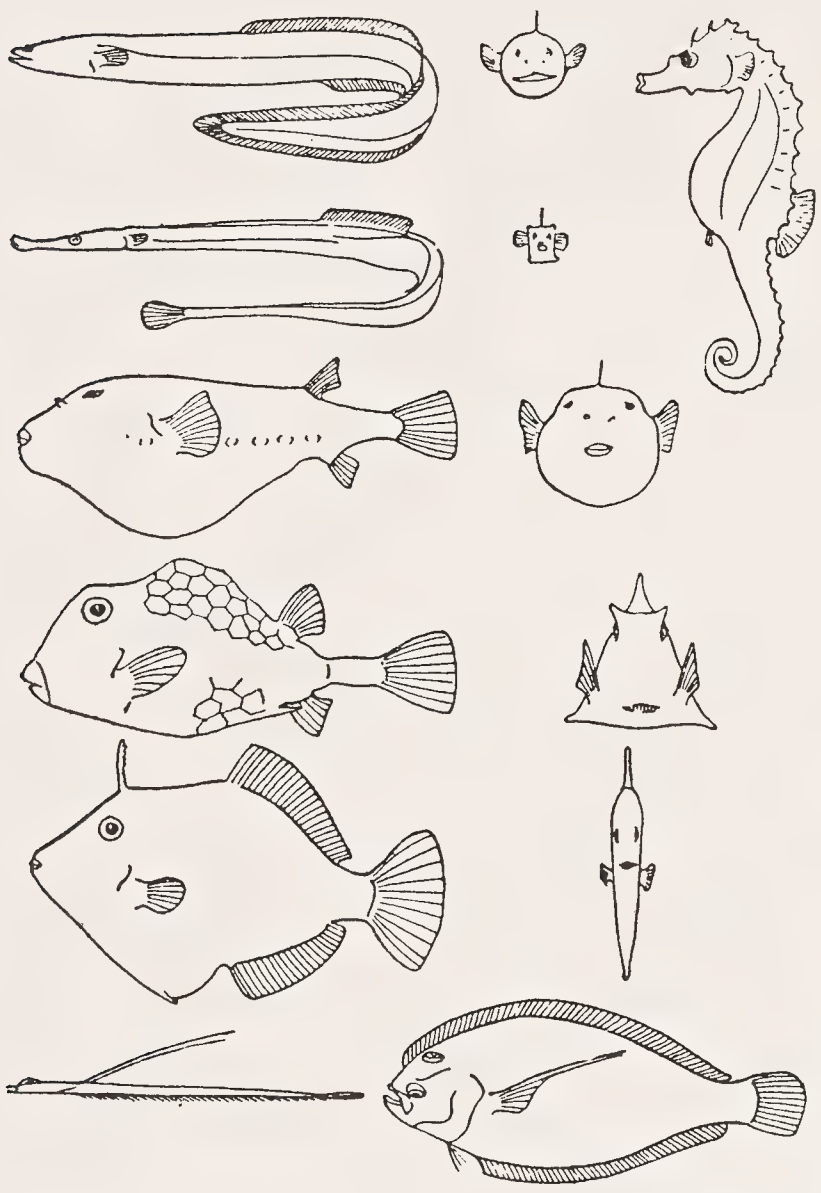
Promethichthys prometheus (Cuvier and Valenciennes)



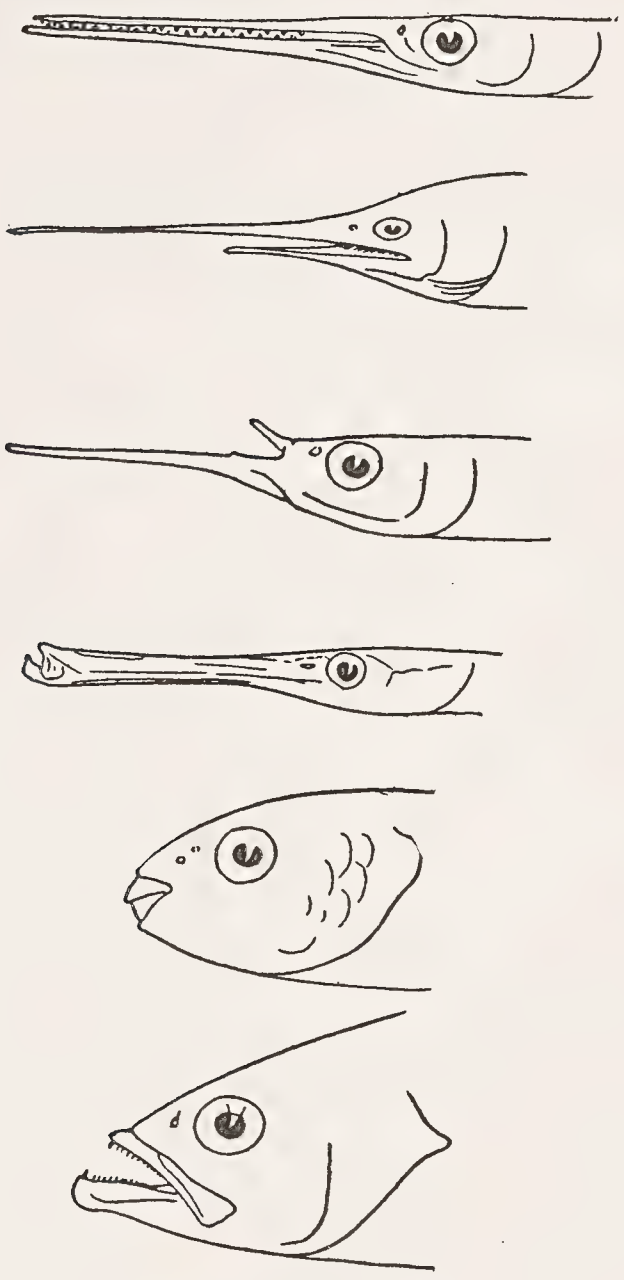
Field Characters.—Medium sized, elongate, slender, compressed, fusiform fishes; mouth large, with strong fang-like teeth in front of each jaw, both jaws with an outer

Section taken from the book showing the method of presenting the various species.

The book is to be highly commended for the careful and accurate manner in which this great amount of information has been brought together and made available for the lay reader, the student and the field worker. Possibly even the Bermuda tourists who flock to the Island in such numbers and whose knowledge of fishes is perhaps rather limited, to whom a sharksucker might signify some species



Various Forms of Fish
Eel, Pipefish, Puffer, Trunkfish, Triggerfish, Flounder and Seahorse.

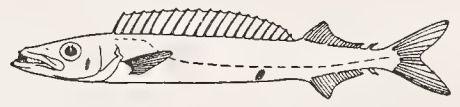


The Mouths of Fish
Gar, Spearfish, Halfbeak, Trumpetfish, Parrotfish and Snapper.

Two pages from the book showing in outline the various forms of fishes and their characteristic mouths.

of "racket" rather than a creature of the deep, would find the book useful.

The "Field Book of the Shore Fishes of Bermuda" is one of the natural history series of field books issued by G. P. Putnam's Sons and is published under the auspices of the New York Zoological Society. —*W. R. B.*



Through the courtesy of the American Museum of Natural History, the Department of Tropical Research of the Zoological Society held an exhibit in the Educational Hall of the Museum, showing the Bathysphere, deep-sea apparatus, scientific collections and paintings from the field work of the Department, made at Nonsuch in Bermuda.

On the night of the opening of the exhibit, January 27, the Director delivered an illustrated lecture in the auditorium. The exhibit was on view to the public from January 28 to February 21, and attracted a great deal of attention. During this time it was visited by 26,426 visitors.

After the exhibit the Bathysphere was shipped to the Century of Progress Exposition at Chicago where, with a model of the *Arcturus* it will be shown, beneath Prof. Piccard's gondola.

On the recommendation of Doctor Gregory and Doctor Sherwood of the American Museum of Natural History, the Executive Committee of that Institution have unanimously appointed Doctor William Beebe a member of the Staff of the Department of Ichthyology, with the title *Research Associate in Oceanography.*

General Information

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee of the Society.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.
New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

Publications

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Technical and generally taxonomic description. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Irregular. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Technical and generally taxonomic description. Volume I completed. Volume II in preparation. Irregular. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society; devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-four volumes completed. Volume XXXVI in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collection of Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Publication temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. 21 editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
View of Park: Book; 24 pp. 75 color ills.
Post cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park.
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Pheasants: Their Lives and Homes (Beebe); 2 vols. 4 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

For all publications, other than those referring to the Aquarium or Aquatic Life — address: H. R. Mitchell, *Manager, 185th St. and Southern Boulevard, New York City.*

Guide Book: Official guide to the Aquarium collections (Townsend). Profusely illustrated, three editions issued. Published as needed.
Sea Shore Life (Mayer); 181 pp. 119 ills. *Out of print.* To be re-issued.
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend); 17 pp. 21 ills.
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger); (*out of print*).
Gaff-topsail Catfish (Gudger); 45 pp. 12 ills.
Galapagos Tortoises (Townsend); 82 pp. 45 ills.
Locomotion of Fishes (Breder); 138 pp. 45 ills.
Marine Fishes (Nichols-Breder); 192 pp. 263 ills.
Fishes in the Home (Mellen); 178 pp. 63 ills.
The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs. In boards.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs. In boards.

For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues wil be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Manager, Zoological Park, 185th St. and Southern Boulevard, New York City.*

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VOL. XXXVI, No. 3 May-June, 1933

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Vol. XXXVI, No. 3 May-June, 1933

Contents

THE picture on the cover is the photograph of a rare fish—*Pantodon buchholzi*—from equatorial west Africa. It is reported to be a flying fish and a casual glance at the enlarged lacy fins might support this theory, but it is probable if the fish leaves the water at all it is only to skitter along the surface, snapping up whatever insects it may find. The specimens on exhibition at the Aquarium are rather particular about their diet, refusing anything but cockroaches. These, however, are eaten with avidity. The hairlike processes extending from the ventral fins are used as stilts when the fish is resting near the bottom of the water, supporting the body, motionless, an inch and a half or two inches above the floor of the aquarium. The total effect of the extremely odd fins is one of bizarreness rather than of beauty although each, as a part, is very attractive.

—*C. W. Coates.*

Daniel Bacon .....*Frontispiece*
Portrait

The Bacon-Andros Expeditions 55
C. M. Breder, Jr.

Young Tarpon—Andros Island 65
C. M. Breder, Jr.

Leaf-fish Behavior 68
C. W. Coates

Echinoderm Enemies of Fish 72
E. W. Gudger

Pearl Fish from Nassau 79
C. M. Breder, Jr.

A Lobster Burial 80
C. M. Breder, Jr.

Pantodon buchholzi Peters .....*Cover*

Andros Island (Map) 56

BULLETIN

New York Zoological Society

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Editorial and Subscription Offices, Zoological Park, New York City, Elwin R. Sanborn, Editor.

JUL 31 1933

Mr. Daniel Bacon exploring a thicket on South Andros. Mr. Bacon, good friend to the Aquarium's interests and life member of the New York Zoological Society, has sponsored and ably lead three expeditions to the Bahamas and numerous shorter trips in local waters. The chief purpose of each has been the furthering of biological research. Although not as spectacular as the collecting of specimens for public exhibition, the work of these trips has been of great importance to the institution. The field observations made on them, coupled with subsequent laboratory study, has resulted in genuine improvements in the methods of maintaining fishes in captivity as well as increasing our understanding of the interactions between aquatic organisms and their environment. Field studies concerning the effects on fishes of chemical variations of natural waters have occupied a prominent part on these trips. The information so obtained has been used to much advantage for properly conditioning water for the Aquarium displays. The accompanying article tells something of the more general observations made and experiences met with in the process of gathering such data on the two most recent of the Bahama expeditions; those to Andros Island. The above photograph taken from within a small cave on South Andros in the Grassy Creek region, does not show a tangled wilderness, as one might suppose, but is actually a sisal farm.

BULLETIN
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The Bacon-Andros Expeditions

C. M. BREDER, JR.

Assistant Director, New York Aquarium

Illustrations from photographs made by the author and various members of the Expeditions.

CRUISING with an able and experienced yachtsman is an event that most of us consider something to be looked forward to, and later to be long remembered. When the yachtsman happens to be Commodore Daniel Bacon, and the occasion of the cruise the pursuit of natural history in Bahama waters, there can be little left for the desire of most naturalists. Thus it develops that there lives in my memory two delightful trips to Andros Island in the successive years of 1932 and 1933. The memories are twofold: One being that of the companionship of the genial host and sponsor of these trips, and the other the inherent biological interests.

Andros Island, the largest of the Bahamas, according to the charts, is actually an archipelago of numerous islands ranging from mere rocky points to masses sufficiently large to support fresh-water lakes. Taken as a whole the group is about as long as Long Island, New York, and in places twice as wide. The seacoast and reefs are well known to naturalists. On the west side are shoal waters covering extensive marl beds which support a very considerable sponge industry. On the east side the deep waters of the Tongue of the Ocean reach to the most extensive, fringing reef in the northern West Indies. It is here that Dr. R. W. Miner has collected the material for his elaborate habitat group, depicting a typical coral reef which is now under construction at the American Museum of Natural History. Inland Andros, on the other hand, is not nearly so well known to naturalists; consequently, for this and other reasons, it was selected as a site for biological exploration.

The first trip (1932) was directed to an area farthest from any coast, in order to learn just how much of a fresh-water habitat might have been developed on such a purely oceanic island composed, as it is, of limestone basically originating from coral reefs. In order to reach the desired location it was necessary to enter the inland waters from the west side of the island. Most of the drainage is to that shore since the highest land is along the east coast. Arriving at the latter shore by launch from Nassau, which lies east of the Tongue of the Ocean, it was thus imperative to pass around the island or go through one of the numerous passes. The latter course was selected. These passes, in this case North Bight, are smoothly floored with soft calcium mud, the marl of the region, which is in part triturated coral and shell and in part the products of precipitative processes.

The passes are all very shallow and of remarkably uniform depth, due to the leveling effects of the silting marl. Since our launch, the *Escape,* drew four feet of water, and many of the so-called channels were of just about an equal depth, it meant long hours of travel at reduced speed in which the hull actually plowed

through the soft surface of the white mud. We left a surprisingly stable ribbon of white, as a record of the propellers' efforts to shove us along through the quiet waters of the anastomosing channels separating the various islands. As the tides are not great in this region we were forced to exert more than ordinary care when moving on other than a rising tide. Due largely to the excellent judgment of our guide, Jackson Hepburn, a native of Andros, we got through with no serious delay. Before his able services were obtained, however, there was an occasion when, because of faulty instructions, an improper pass through the fringing reef on the east shore was taken. This nearly resulted in termination of the expedition, if not extermination of the entire party. From between two reefs, we entered a boiling sea which seemed to have neither rhyme nor reason in its utter confusion of direction. There we spent about fifteen anxious minutes of violent tumbling. Were it not that the *Escape* is an exceptionally able boat and heavily powered with twin screws, no one could have managed to come through. This is in no sense a detraction from the exquisite handling displayed by Mr. L. D. Huntington, our companion on this first trip. There are few who could have managed so well.

It seemed though, with the acquisition of Hepburn, that all such dangers were past, so after polishing the hull on the soft, coral mud for a day, we came out on the western coast. This presented a remarkable contrast to the reefy shore we had first encountered. Here the marl bank extends miles to sea, and after working out of the pass we were forced to keep a few miles off shore in order to float. Traveling up the coast it took but little time to reach the inlet we had decided upon, known as the Wide-opening. Here it was necessary to anchor off shore about a mile, and take to small boats for the rest of the journey which then changed from a cruising to a camping party. A skiff powered with an outboard motor and towing a dory made up the outfit.

Once inside the inlet we found ourselves in a delightful lagoon populated with a pleasing variety of aquatic birds. Flocks of ducks kept rising to get out of our way, while stately white herons waded close to shore, and kingfishers

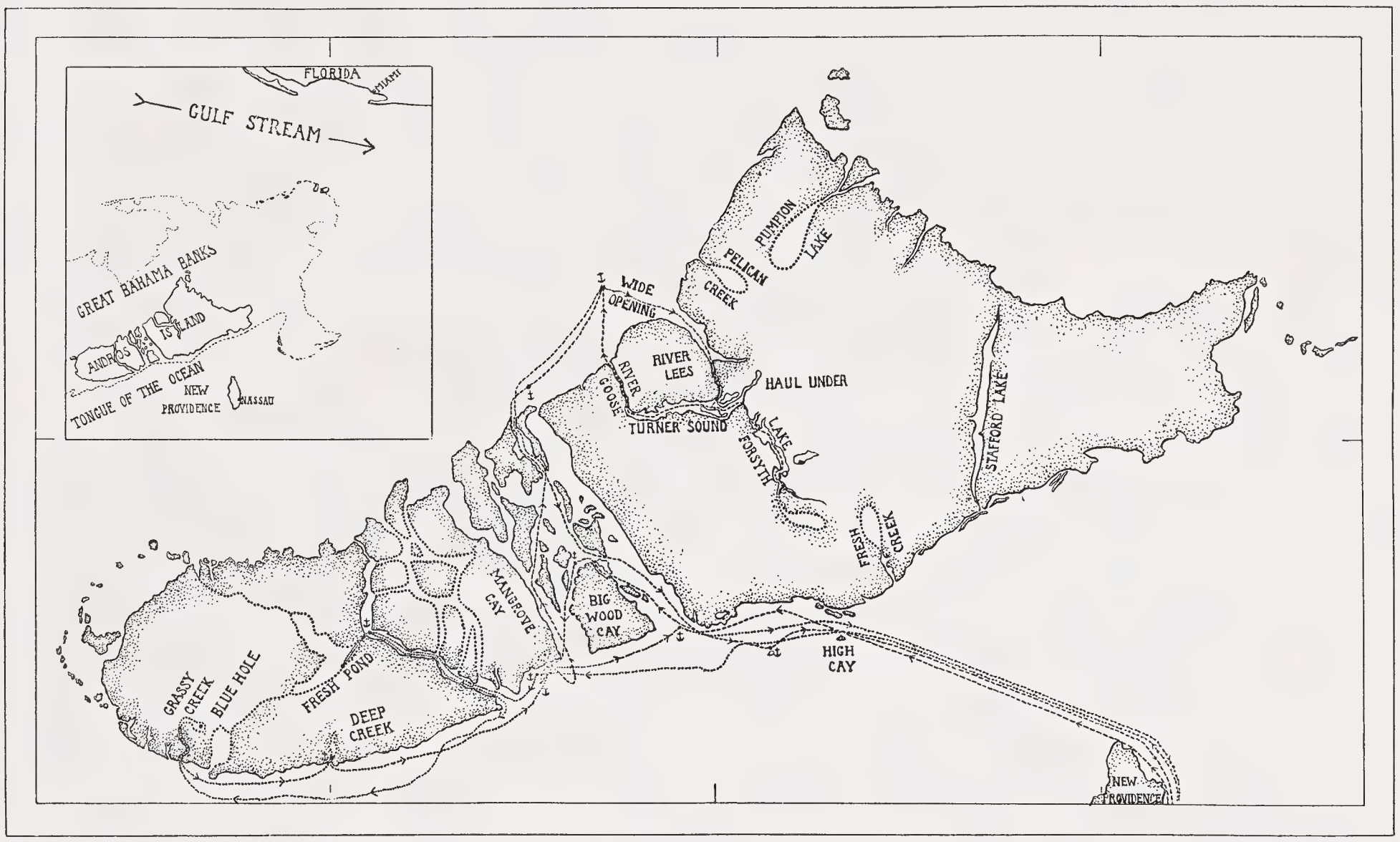
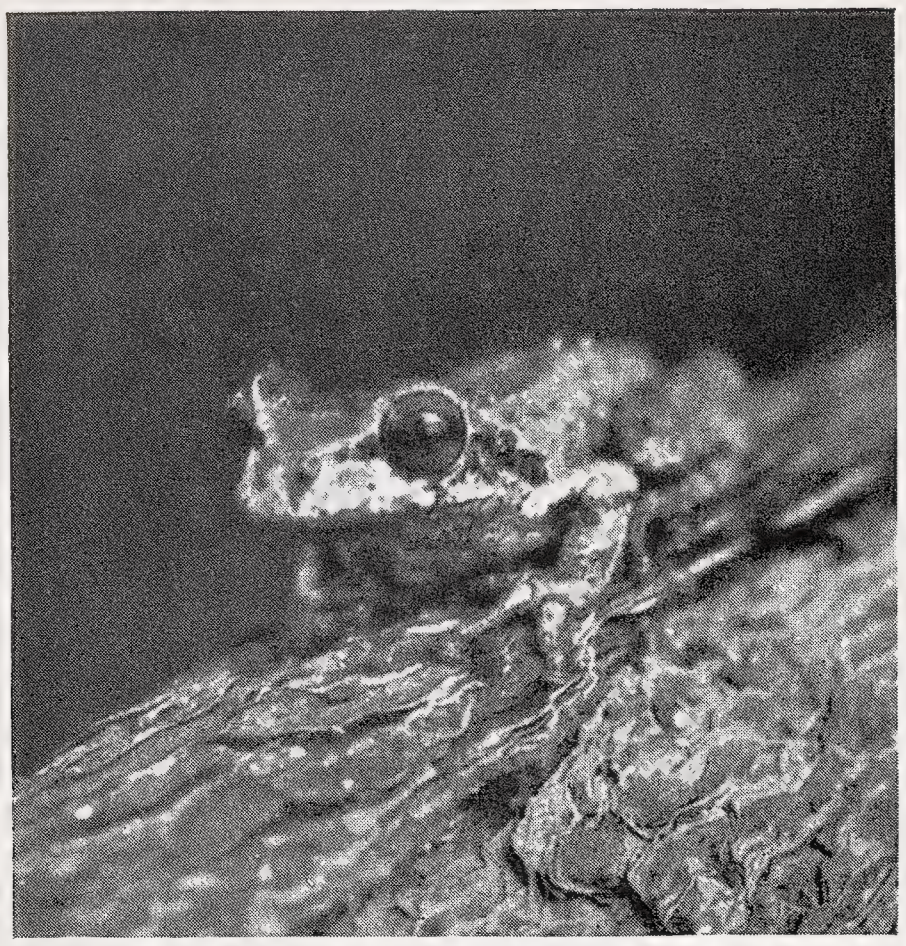


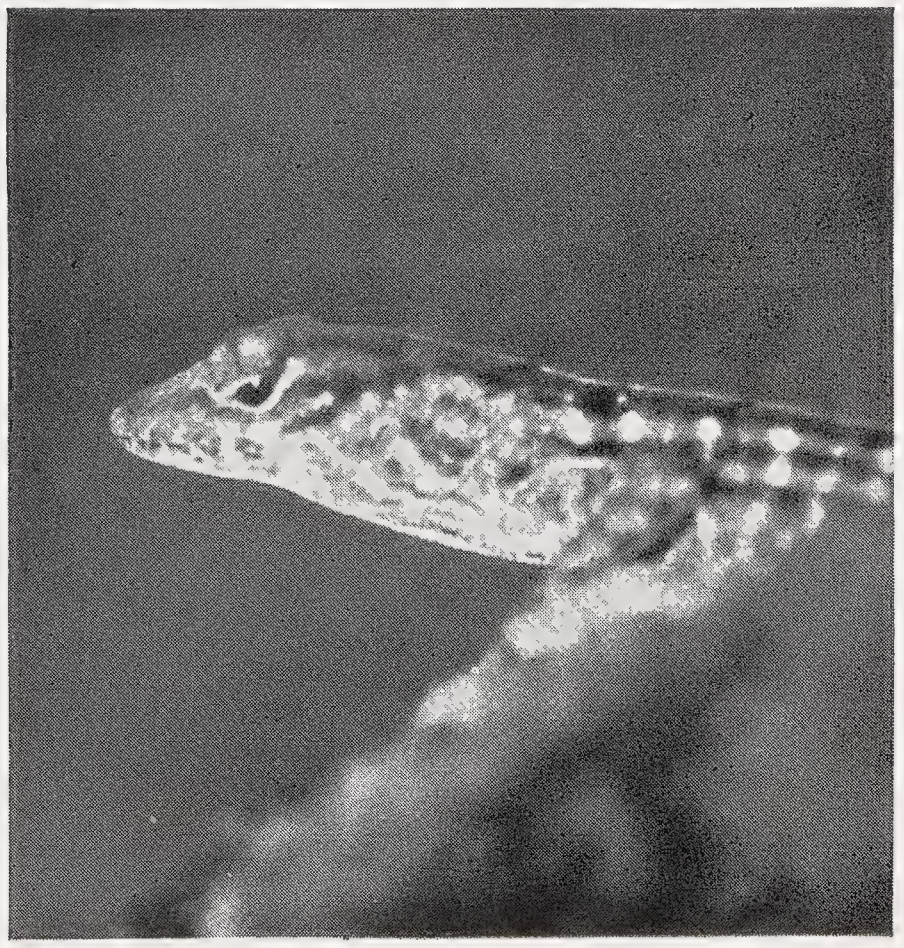
Chart of Andros Island showing routes and localities of the Bacon expeditions. The heavy dashes refer to 1932, and the dots to 1933. The approximate contours of waters that hitherto have not been charted are indicated by dotted lines. Those that were not visited are based on the reports of natives. All represent fresh water except the passes marked on Mangrove Cay. Collecting sites are marked with dark circles. Drawn by T. Schewe.



A small tree frog of Andros (*Hyla septentrionalis*). These were very hard to find since the country was arid and the breeding season not nearly ready to begin. The natives state that in April and May the fresh-water ponds and lakes are noisy with frog choruses.

chattered at us. Our first camp was made on the shores of the River Lees, a narrow, relatively deep, canal-like passage between the Wide-opening and Turner Sound. Here the night was spent in a pleasant grove of mahogany trees. Small lizards (*Anolis*) scampered about, and a tree frog (*Hyla*) was found. The latter suggested the proximity of fresh water. In the morning before leaving, a scouting trip found

A curly-tailed lizard at the Berry Islands. This small and friendly lizard permitted considerable familiarity, but all the while we were at close range displayed nervousness by tightening and relaxing its spring-coiled tail. The movement was regular and not unlike that of the hair-spring of a watch, except being very much slower. The photograph caught probably the most relaxed position of the tail that we noted. Taken on a previous expedition to the Bahamas with Mr. Bacon.



a large lake-like rain pool within a few hundred feet of the camp. Doubtless, at the proper season, this is the site of a brilliant frog chorus. All about the mangrove roots, which in part fringe the River Lees, could be seen the ubiquitous West Indian puffer (*Tetraodon testudineus*), or the lurking shadows of the gray snapper (*Lutianus griseus*). All of this increased our enthusiasm for a pleasant camping trip amid a splendid variety of animal life both above and below

the surface. Little did we dream at the time that this camp site was the only one to be replete with such forms. Passing on to Turner Sound we encountered large tarpons leaping where the River Lees joins the Sound. This brought to mind the perennial question that has pestered naturalists for years—"Where do they breed and what do the early stages look like?" The problem was not solved but some significant data were subsequently uncovered that give a further lead. Crossing the Sound was uneventful. In most places it could comfortably float our tiny craft, but then only

One of the small lizards of Andros. This one, *Leiocephalus carinatus*, did not show the curly tail of the Berry Island *Leiocephalus*.

with an occasional objection in the form of a kick-up of the outboard motor.

Finding another creek, variously known as the Haul-under or Milk River, we left Turner Sound and gave up the use of the outboard motor in order to pole into its shallow mouth. Here we were embarrassed by a dense tangle of mangrove and other bushes, as lush as any to be seen on Andros. Only the free use of machettes made a passage relatively simple. It was noted that there was a distinct flow, this "river" actually being a flowing stream, and not a mere tide-way as are most of the Andros rivers. Due to various causes, it was distinctly turbid, with marl nearly the color of well-watered milk. At least the first part of the name, Milk River, is entirely appropriate. The significance of the other name, Haul-under, would be evident to all who, even with the aid of a bush knife, might go through it. A scrambling out on the bank revealed that this dense growth forms an arcade along the waterway and is flanked on either side by flat, prairie-like country that supports only stunted and sparse vegetation. The soil is thin and poor and much of the surface is either an outcropping of eroded limestone, or plains of the ever evident desiccated marl. The periodic hurricanes that rake this low country from time to time distort or kill most of the growth and sweep off into the sea much of the slowly accumulated soil; thus, vegetation never really gets away to an adequate start. It seems to be always aborted by the force of storms, against which there is an insufficiency of protection, or starved by being robbed of a sufficient depth of soil.

Once through the Haul-under, we broke upon the silent fastness of Lake Forsyth and were again able to employ the outboard motor. This body of water at first glance appeared not to be very different from the recently traversed Turner Sound, except that not unattractive coppices of pine relieved the dismally flat landscape. The lake had been named for the Commissioner of Andros and the Berry Islands, Mr. E. W. Forsyth. One of our first stops before going inland was to pay our respects to this kindly gentleman at his residence on Mangrove Cay. He is one of the very few white persons living on Andros. Most of the small settlements, nearly all of which occur on the east coast, are exclusively Negro, to the number of some 5,000 persons. We are deeply indebted to Commissioner Forsyth for his cordiality and helpful advice.

After having well entered the lake we looked about for a suitable camp site. This was discouraging business and nightfall nearly overtook us before we were established. The shore line consisted of but two kinds; either it was of the increasingly annoying, soft and pasty marl and quite impossible, or it was of limestone so eroded that it presented the general appearance of Swiss cheese. Finally a spot of the latter type was selected, which seemed to be less objectionable than the rest. While it cannot be described as either especially comfortable or particularly delightful the writer, at least, found it to be distinctly the most curious camp site in which he ever settled.

The following morning when we arose to take stock of the place to which we had come for the purposes of biological study, we were for the first time in a very receptive mental state. It seemed something was wrong. The place was altogether too quiet. The air was still, yet the quiet was not that of a breathless morning. A few lizards scampered about but that was all. A swift shadow prompted looking up. Two buzzards were circling over the camp. Then it dawned on us that the missing element was that usual one of bird voices. What had become of the ducks, herons and kingfishers that were so abundant in the inlet? Why were there no warblers or sparrows in the bushes and why were those buzzards so attentive? Breakfast prepared by the skillful hands of Mr. Bacon's man, Fred, helped considerably, but by this time those two buzzards found a perch on a stark, dead tree and kept an interested eye apiece on us. These death-watchers are certainly fascinating enough on the wing, when considered as master aviators, but their concern over our activities was anything but enlivening.

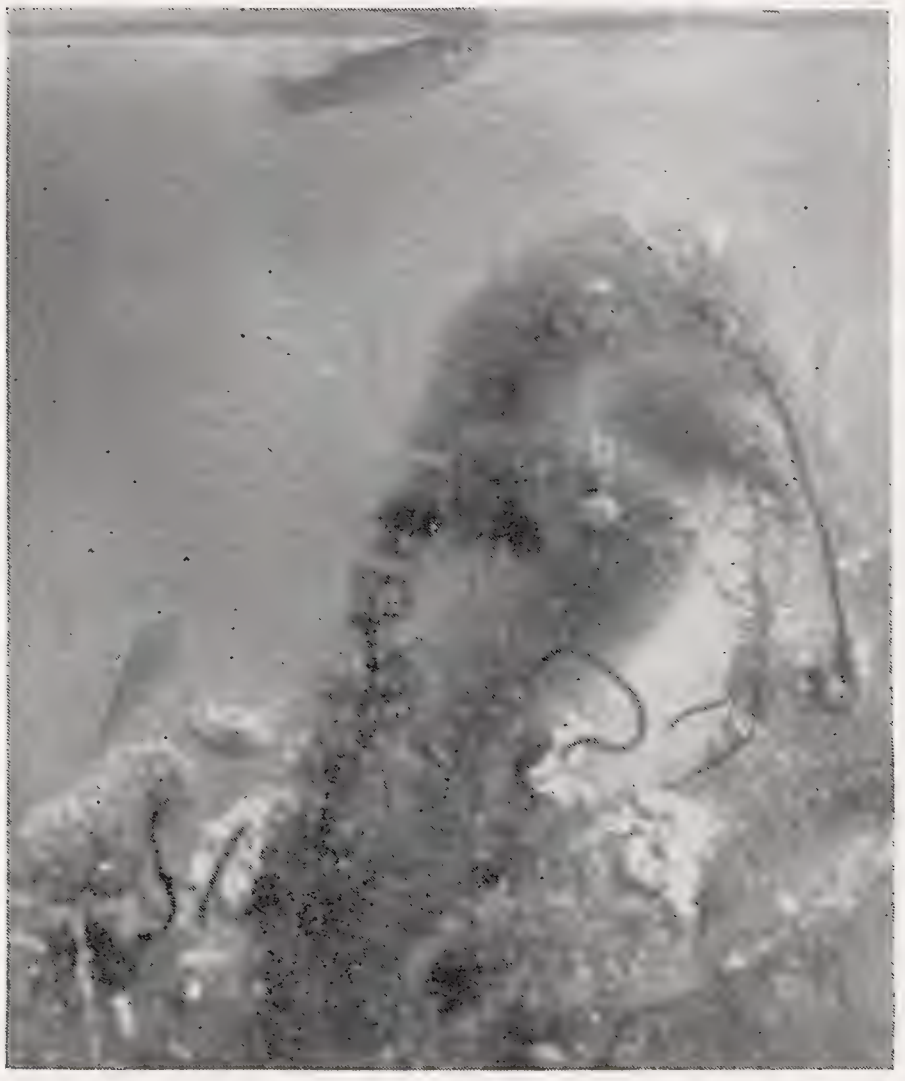
As we later went about our proper collecting pursuits this pair of birds followed our skiff, and when we returned to camp circled their way over us as a convoy. On investigating the shores of this lake exactly one other bird was seen—a single wintering Maryland yellow-throat, and once at night a single call of some heron passing over was heard. The only terrestrial vertebrates to be found were a fair number of lizards, small

Milk River. This milk-white stream connects Lake Forsyth with Turner Sound and for much of its length is so overgrown with vegetation as to make the use of machettes essential for passage.

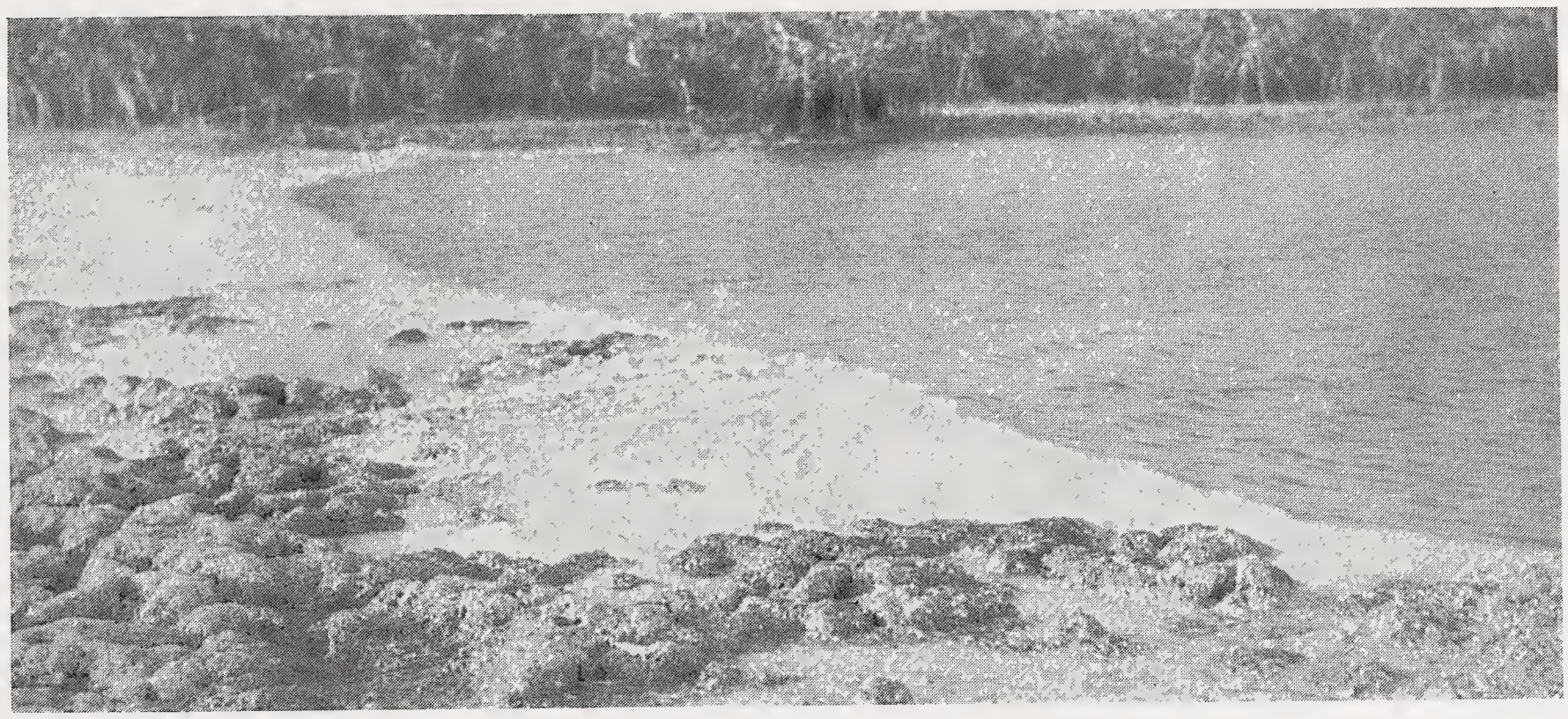
Anolis and slightly larger *Leiocephalus,* and by tearing open stunted palms two kinds of frogs (*Hyla septentrionalis* and *Eleutherodactylus ricordii*) were taken in small numbers. Probably the latter are fairly abundant but during the dry, winter months remains, for most part, well hidden.

The turbid waters of this shallow lake, six feet in the deepest part sounded, were somewhat of a surprise. The first setting of seine yielded an abundance of fish-life. Eleven species in all were caught. As these same species were taken again and again in various places, we believe the number gives a representative sample. The striking part of it

The bottoms of the fresh-water lakes are covered with a curious worm-like algae (*Batophora*). This, in turn, is generally dusted with the precipitating white marl, toning the color down to a pastel tint.



An aquarium view of the algae (*Batophora*), and some of the fishes, (*Gambusia manni*), that live amid its fronds. The milky appearance of the water and the precipitated marl is evident here.



The soap-suds-like froth of Andros fresh waters. Every cove into which the wind blows for some little time acquires such a layer of suds.

is that they are all marine or at least brackish-water types, although this water was quite potable and on chemical analysis showed itself to be so slightly contaminated with salt as to be considered thoroughly fresh. It was, of course, saturated with calcium, being bedded in coral rock and holding much marl in suspension. Incidentally, no young tarpon were to be found, as at first was hoped. Three of the eleven fishes have been described as new.[1] Although they greatly resemble species from other West Indian localities they have apparently undergone a sufficient change to render them recognizable in this unusual type of habitat.

If the camp was depressing by day it was positively eerie by night. A new moon silhouetted the two buzzards on their scraggly perch of dead wood and cast long shadows around the perforations in the desolation of eroded rocks that shored

[1]Breder, C. M., Jr. An annotated List of Fishes from Lake Forsyth, Andros Island, Bahamas, with the Descriptions of Three New Forms. Amer. Mus. Novitates, No. 551, August 15, 1932.

Some of the more rugged landscape near the mouth of Grassy Creek. The effects of wind and rain on the comparatively soft and readily soluble portions of this calcareous rock is especially notable in this region.

A detail of the firm meringue-like suds that piles up on lee shores. When this size is reached great masses are torn off by the wind and driven inland to cling to the shrubs like great tufts of cotton.

the milk-white lake. So much did the place remind us of Doré's sketches of the nether regions that our dwelling was unanimously dubbed Camp Inferno. The reasons for this curious condition are not far to seek. The cover of soil and vegetation is very scant and as previously pointed out is not infrequently torn up by hurricanes. At such times, also, there is usually an inundation of sea water. Thus few organisms incapable of more or less protracted emersion in sea water are able to survive. Evidences of hurricanes are everywhere, although no strictly recent one has apparently flooded this particular region.

Insects and small fruits are not abundant. There is, consequently, a rather meager foundation on which a food-chain can be built up. One of our companion buzzards, while waiting for us to expire, succeeded in catching a lizard. Although such behavior is not entirely unknown it is distinctly unusual and gives a hint of the poorness of the region. With conditions such as these a question may be properly asked concerning the source of sustenance of such an abundance of fish life in waters where there is naturally a small influx of food from the land. It so happens that a peculiar algae (*Batophora*) floors the bottom of Lake Forsyth to a considerable extent. Examination of the stomach contents of the smaller fishes showed them all to be feeding on this plant or the micro or near-micro-organisms dwelling in its fronds. The larger and less numerous predaceous fish feed, in turn, on these fishes making the lake practically self-contained in this respect. As previously indicated these fishes represent an invasion from the sea although the abundant marine invertebrates have not made a similar invasion. Except for a few land or semi-terrestrial crabs the macroscopic invertebrates present are definitely of fresh-water origin. These are mostly insects, such as dragon-fly nymphs, which in the adult form are often carried long distances on the wings of strong gales. The only form not of this type is a single species of pond snail (*Physa*) which occurs sparingly. Thus it becomes evident that in this geologically-young, fresh-water region but one strictly fresh-water form, not possessing ready means of travel, has established itself. Just how this form got across from the mainland is certainly not clear.

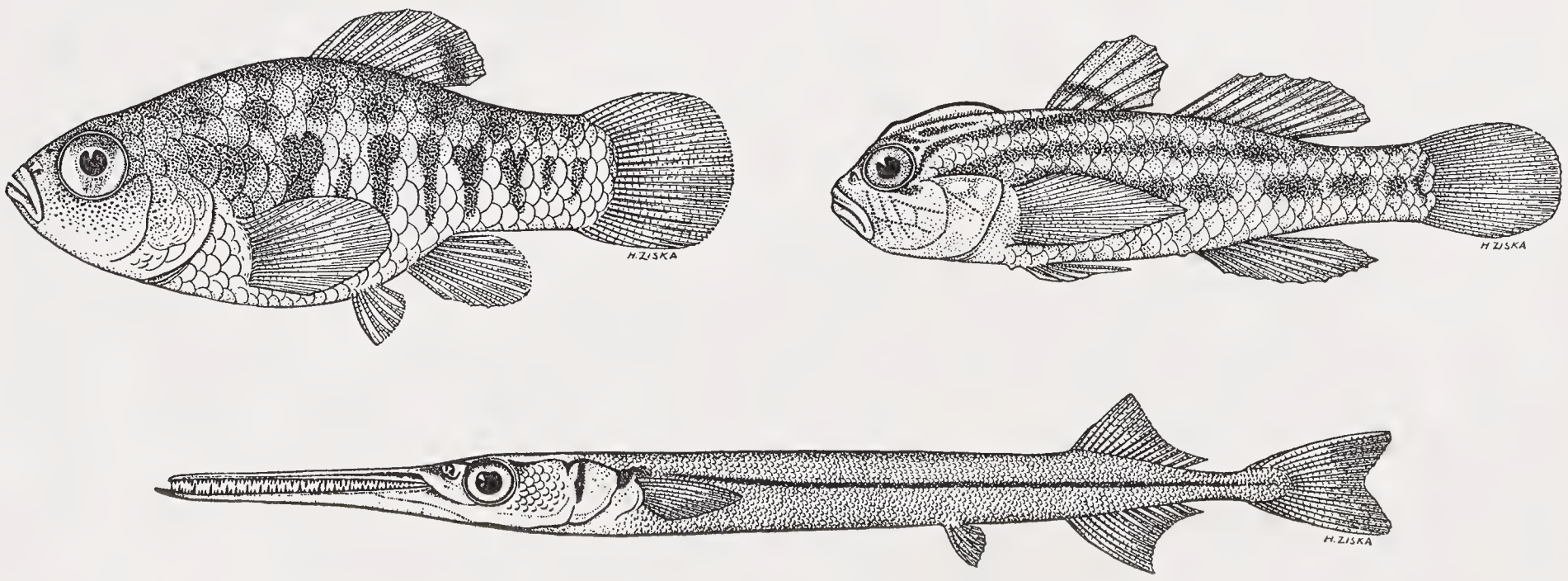
Leaving Lake Forsyth with its disappointed buzzards, after not having seen a single, stray, prowling Negro since we left the spongers on the west coast, it was a considerable relief to board the patiently waiting *Escape* and make our way back to the more friendly parts of the island.

Before going on to other parts of Andros, however, there is one item, concerning the efficiency and energetic capability of our guide that cannot pass without mention. Due to some maladjustment in the outboard motor, we used much more gasoline than was expected; in short, we found there was not nearly enough to get us back to the *Escape*. That meant rowing, poling and struggling, five men in two heavily laden, small boats, a matter of some thirty-five miles. The only alternative was for one person to go light and bring back the needed gas. Hepburn thought he could do it in two days; one to go and one to return. We thought, more likely, that it would be three. Finally, after some discussion, he was sent off with the skiff, a blanket and some food, at noon on January 24. He rigged a sail of his blanket but we knew he could only go with the wind, by means of this crude outfit, and most of the way the wind was unfavorable. It was mostly a matter of sheer man-power for about seventy miles, there and back. We wondered considerably just how long it would take him. That night I was awakened by Mr. Bacon, who was peering out into the darkness. He said he thought he heard some one prowling about—the last thing we expected in this lonely spot. Just then there emerged into the dying glow of our old fire, a figure. It was Hepburn. We all were up, and by now wanted to know what had happened; why he had turned back, and so on. Hepburn seemed surprised. He had not turned back, he had gotten the gasoline. There it was in the skiff. A glance at our watches showed it was 3.00 A.M. He had made the complete trip in fifteen hours! If he was tired, he showed no evidence of it next day. Mentioning the fire makes it necessary to recall that the nights were amazingly cold, mostly with the damp chill from fresh water. Only by building a large fire before our open lean-to, prior to turning in, could we remain warm enough to stay asleep. Even so we not infrequently awoke in the early hours before sunrise, chilled through because the fire had died down too low.

The camp on the shore of Lake Forsyth. The eerie nature of this locality can be well visualized from this photograph, which was taken late in the afternoon on the return from a fishing trip. The buzzard which circled all day over our heads can be seen preceding us to its post of vigilance for the night—the dead tree immediately in front of our tent. These watchful waiting harbingers of death helped to emphasize the dreariness of the landscape.

The more southerly parts of Andros Island, visited on the second trip (1933), were found to be essentially similar to the northern. We encountered more friendly country by spending a greater part of our sojourn near the eastern coast, with only excursions into the interior for purposes of comparison with the previous year. A fresh-water lake entered by way of South Bight presented a similar general appearance to Lake Forsyth, although it must be admitted that it had a more genial atmosphere and life, such as small birds, was much more in evidence. Samples of the fish found appeared to be substantially the same, and still no young tarpon. At this writing the material collected on the second trip has not been fully studied, so these remarks must be confined to the more general aspects of this visit.

One place on the shores of Grassy Creek we thought especially interesting. The formation was unusually rugged and the vegetation unusually dense. Some of the cavities were large enough to be considered small caves and could have been used as very satisfactory shelters. A few places showed evidences of stalactite formations in their initial stages. Travel was difficult due, in part, to the irregular and deeply pitted nature of the terrain, and partly because of the density of the low but intricately tangled



The three new fishes from Lake Forsyth. *Cyprinodon baconi*, *Strongylura notatus forsythia* and *Lophogobius androsensis*. From pen drawing by H. Ziska.

The pupae of a small white moth (*Alarodia slossoniae* Packard) are common on the mangrove leaves of interior Andros. These are deceptively similar in appearance to the eggs of various small lizards that are to be found in the same environment.

growth. We noted there were many small sisal plants in the underbrush the spikes of which, at ankle height, did not increase the pleasure of our prowl. On our return to the anchored launch we remarked on the jungle-like nature of that patch of Andros, only to elicit the information that we had been wandering through a sisal farm! It seems that these plants were placed in small rock holes wherever there was room, in the hope of harvesting the sisal on maturity. A drop in the market price of this product rendered such a harvest unprofitable. The latter

The stunted and tempest-torn mangroves, fringing the shores of interior Andros, support numerous epiphytes of the type here shown. These are, at times, nearly the only green things to be seen on these bushes.

was extremely easy for us to understand.

This region is not far from the breeding site of the flamingoes, for which Andros is probably best known. At the season of our visits none was to be found, as at such times they are wintering in Cuba, according to the natives who always speak of them as Fili-mingoes. Also, the Andros iguana (*Cyclura*) ranges these southern parts but is reported to be so scarce that we decided to spend none of our limited time to hunt for them. Here as in other regions they are

caught with the aid of dogs that run them down.

By this time the highly dissected nature of Andros was thoroughly evident, while from both observation and the description of natives it became apparent that relatively great quantities of fresh and almost fresh waters were to be found. There was such a marked uniformity of for-

Receding waters frequently leave mangroves high and dry. The aerial roots of these plants, when they reach a sufficient length under the influence of gentle breezes, then start to excavate a circular hole. As it requires a nearly perfectly still air for some time, to enable the growing tip to "dig in", these excavations may reach a considerable size. It will be noted that the one illustrated has destroyed all the low-growing vegetation and has exposed the dried marl beneath. The angle that the root makes to the perpendicular is due to the amount of wind pressure at the instant of photography.

A young resident of South Andros and his dog. The latter, answering to the name of "Scorpion", is used by his master to run down and catch iguanas for food. Behind the boy is a bucket of pigeon peas, one of the chief articles in the diet of these people. The price of the portrait was the "ship's biscuit" which the little fellow holds.

We were about to return to Nassau without having seen anything of young tarpon, and had stopped at Mangrove Cay just to pay off some small boys employed as lizard collectors. These, to our delight, had made a collection of about 1,000 specimens in a remarkably short time, under the guidance of Bert Bowlin who rendered valuable service in engineering this operation in our absence. It was at this time that Hepburn said he thought that small tarpon might be gotten in a nearby pond. Without much hope we went ashore to seine another hole; probably to no particular purpose. One look at it gave mixed feelings. So tangled was it with

The village of Deep Creek. A typical Negro village of the better sort. The houses are of coral stone and sun-baked marl, thatched with palm leaf. Most of them are scrupulously clean.

mation and fauna in the places examined, that there is every reason to suppose that the unvisited places are similar. One of the striking features of these fresh waters that also seems of constant occurrence is the formation of large quantities of white soap-suds-like froth to be found in every corner into which the wind blows. Chemical analysis of this will be made, but on a basis of physical appearance and action it would seem to be a natural soap formation that can be accounted for well enough by the peculiar details of these waters.

A sponger on his way to the Andros sponge banks. Note the loose footed sail. In a rough sea this frequently drags in the water. These small boats often ship a crew of nine spongers, under the most unlivable conditions, especially when the vessel is filled to overflowing with damp and reeking sponges.

dead buttonwood bushes as to be almost unseinable, and so filthy as to preclude practically any fish life. However, it was different than any other pool, salt or fresh, so far seen on the islands. Recalling that Evermann and Marsh in Puerto Rico, and Beebe in Haiti caught small tarpon in pools that were reported as foul, our interest revived. Here was opaque red-brown water covering knee-deep mud, mostly of decomposing vegetation which reeked of sulphureted hydrogen; nearly fresh water and different than any other pool in the area.

After much difficulty the seine was set, torn, twisted and finally brought together, enmeshing some sort of fish — sure enough, a seven inch tarpon gleaming and glistening with all the brilliance of a seven foot specimen. Here again were young tarpon, now recorded from three West Indian localities, similar in physical condition. After further struggles with the mud, net, sand flies and broken branches, more were captured; but the fish had all the advantage. The details of this observation will be discussed in another article. Suffice to say, we left in a most satisfactory frame of mind and reached Nassau just in time to find shelter before a nasty blow.

Some of the more interesting, preliminary results of these trips follow. The fresh waters of Andros Island while invaded by marine fishes apparently are geographically still too young to have developed a truly fresh-water fauna of vertebrates, although they seem to be in the process of so doing. The fact that so many marine forms have been able to accommodate themselves to these fresh waters appears to be associated with the large amounts of calcium present. Laboratory experiments, still in progress, tend to substantiate this. The fact that no true fresh-water fishes are present is certainly due to ocean barriers, as various fresh-water fishes can be made to live and thrive in synthetic "Andros fresh water." Marine invertebrates have made negligible progress in the invasion of these waters which is understandable on the basis that they are generally much more intolerant of chemical modifications of the waters in which they live than are fishes.

YOUNG TARPON ON ANDROS ISLAND

C. M. Breder, Jr.

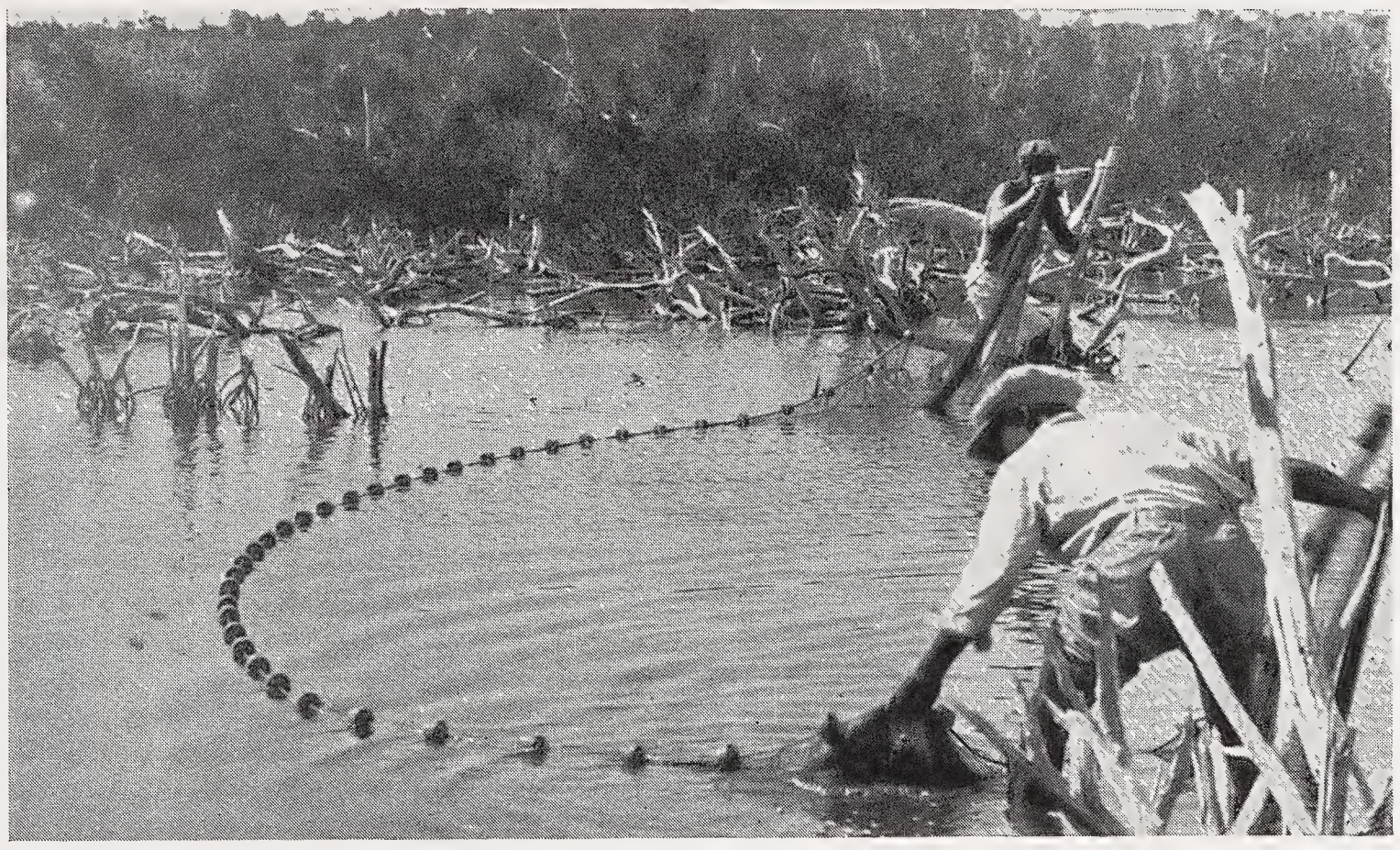
THE destructive hurricane of 1926 inundated a portion of Mangrove Cay, Andros Island, Bahamas. A low portion, well back from the beach and near the settlement, retained a standing pool of water of considerable size. This standing water drowned a dense tangle of buttonwood bushes, the existence and size of which demonstrate a prior lack of water in this depression for a considerable period of years. Since the time of formation this pool has been shrinking, although augmented from time to time by rain. In 1932 there was still no connection with the sea and the water was practically fresh. Recently a drainage ditch has been dug through the beach to draw off this standing water, in the interests of mosquito reduction. There is, apparently, no flooding at high tide and the water is still fresh.

In February, 1933, nine tarpon were caught in this pool and ranged from about seven and five-eighths inches to thirteen and three-eighths inches in total length[1]. Absolutely no other fishes, or for that matter any aquatic life, could be found except a few stray semi-terrestrial crabs. Examination of the stomach contents of these fish showed them to have been feeding chiefly on these crabs. One aquatic beetle was found (*Dytiscus?*) and fragments of a few, small minnows (*Cyprinodon baconi?*). The latter, of course, proves that there were at least some of these present even if we could not catch or see any. The water was opaque, red-brown in color, and smelled strongly of hydrogen sulphide. It was not over a foot and a half deep at any place and was bottomed by a soft mud, so that in wading one would sink nearly to knee depth. This mud, unlike the usual white marl of Andros, was a dark brown and apparently rich in organic matter, the remains of the once dense cover that nestled in this depression. The dead buttonwood bushes still stand, a considerable handicap to seining operations. It was evident to us that many more tarpon could have been caught were it not for this condition. The accompanying illustration shows the condition above the surface. Below it, the brush was of even greater density. Further seining could have resulted only in a completely ruined net. Sand

[1] 15.5 to 28.0 cm. in standard length; 19.3 to 34.0 cm. in total length.

flies were abundant, but no mosquitoes, adult or larval, were encountered.

The local story has it that tarpon came in on the hurricane in 1926 and have been breeding there ever since. At times they have been very abundant but are now about "running out." Many, much smaller than any we obtained, were formerly to be seen along the shores and some have been caught as large as four feet. Not having any proper net, the boys would use old gunny sacks to catch them, which, of course, indicates a very considerable abundance. Our guide tells that in the late spring, or early summer, very small specimens have been seen, which at least checks fairly well with the known time of ripeness. Mr. L. L. Babcock[2], in his very informative book, "The Tarpon", states in summary: "The indications are that the time of spawning on the west coast of Florida is from late June to August." Whether or not the natives are correct in stating that this body of water, until the recent ditch was dug, has not been connected with the sea since 1926, it is undoubted that tarpon have been there for some time, especially as they have been used by some as food.



Seining for tarpon on Mangrove Cay. Some idea of the difficulty of these net operations may be gained by the number of snags above the surface. Much more was broken off completely below the surface. The man in the foreground is struggling with such a piece and is standing in only a few inches of water, his feet having sunk in the soft mud until they encountered some completely buried branches or old roots.

The most striking part of the entire matter is that the two other tarpon records of this sort describe habitats essentially similar. The Puerto Rico record of Evermann and Marsh[3] states that they "were seined in a small brackish pool of dark-colored water, not over five feet deep in a corner of a mangrove swamp . . . entirely separated from the ocean by a narrow strip of land scarcely twenty-five feet wide." The Haitian record of Beebe[4] describes the habitat in part as follows. "From the waters of the Gulf, the lagoon is separated only by a narrow dike built up, apparently, by the action of the storm waves at high water. I walked into the ooze at the edge of the lagoon and out to the center. There I found half a foot of mud and about eighteen inches of water. This was green and muddy but not slimy. It was impregnated with sulphur and the odor of this element rose strongly from the disturbed bottom . . . This unprepossessing liquid was filled with innumerable small insects, which, upon examination, proved to be water boatmen . . ." With the exception of one small snook all fishes Beebe collected were tarpon.

One other record of small tarpon does not describe the habitat as foul. Eigenmann[5] obtained small tarpon at Pinar del Rio, Cuba, "from a deep pool" which was presumably clear,

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[2]Babcock, L. L. The Tarpon. 3rd edition, 1930. pp. 1-135. Privately printed.

[3]Evermann, B. W. and Marsh, M. C. "The Fishes of Porto Rico". Bull. U. S. Fish Comm. 1900. Vol. XX, Pt. 1, 1902.

[4]Beebe, W. "A Tarpon Nursery in Haiti". Bull. N. Y. Z. S. Vol. XXX, No. 5, Sept.-Oct. 1927.

[5]Eigenmann, C. H. Report on the fresh water fishes of western Cuba. Bull. U. S. Fish Comm. 1902 (1903) 211-236.

fresh river water. Since the tarpon is a fairly abundant fish in its range, its population must be supported by a large number of juvenile fishes. While the present record will tend to support the idea that these foul backwaters act as tarpon nurseries, the writer does not believe that this is necessarily the case. In the first place, such swales are certainly not sufficiently numerous in the West Indies to accommodate the number of young necessary to maintain the known population. For example, only a single such locality was found after two seasons on Andros Island, during which time most of the activity was confined to examining brackish and fresh pools. Also this is a relatively recent body of water, being simply the aftermath of an unusually violent hurricane. In the second place, in at least two of the three "nursery" records, the fish were landlocked, or at least their egress to the sea was not easy.

An alternative suggestion is offered. If, as Babcock summarizes, "the fish probably spawn somewhere off shore in shallow water or in sheltered brackish waters," the young fish must either migrate to these lagoons or be hatched in them. If the pool becomes foul enough, because of local conditions, possibly other fishes so trapped that have not so great a tolerance die off and cease to be a competitive factor. It would seem that young tarpon are most unusually tolerant of such suffocating environments. At Andros no other fishes were caught at all, although a few *Cyprinodon* were found in the stomachs of the tarpon as already noted. In a clear pool not two hundred feet away, both *Cyprinodon* and *Gambusia* were abundant and no tarpon were present. Other fishes trapped with the tarpon may have formed food for the latter while they lasted. At any rate only the tarpon remained in abundance in the landlocked, foul pool. On the other hand, pools open to the sea may permit early passage of young tarpon back to the ocean, or in clear, landlocked pools the successful survival of other forms may present too much competition for them. Germane to this is the fact that there are numerous records from Florida, Texas and Panama of slightly larger tarpon in clean salt or brackish water as well as the Cuban record already mentioned. At least on Andros Island all other fresh, brackish or salt pools hold a good variety of species, and a large number of individuals of other fishes.

The question then resolves itself into the following: If the young tarpon are not trapped and go back to the sea, where are they to be found; or, if these foul pools are actual nurseries, why are there so few of them, and how do the young tarpon get out in sufficient numbers to keep up the supply? There is the promise on the part of certain Andros Islanders to collect smaller tarpon this summer when they are sure such will appear. Considerable hope is held that this promise will develop, to assist in the eventual solution of this aggravating question.

A cursory examination of the scales of the specimens was made, with the thought of determining the age. The marks, however, proved to be difficult of determination, although for the size of the fish there were an unexpected number of the scale-rings which are usually to be interpreted as the result of seasonal variation. Thus they may be actually older than their sizes would suggest and badly stunted, or the marks may represent violent and non-seasonal fluctuations in the food supply, or other factors. The largest specimen suggests an age of three and a half to four years, and the smallest, one and a half to two years. These figures carry with them no conviction that such is the case, but are mentioned only to call attention to possibilities.

Since the above was written, Mr. E. W. Forsyth, the Commissioner of Andros Island, has written a letter to me from which the following is extracted. "I have known of these fish (young tarpon) for about thirty years and they are found in some completely landlocked ponds where only very unusual tidal waves could account for their existence. One such pond at Mangrove Cay has yielded them, to my knowledge, for a very long time before the hurricanes of the past decade. At times this pond goes dry with only a few moist places on the surface and one little hole the size of a well that retains water. Yet from year to year they re-appear in considerable numbers with the rains. I have seen the bottom of this pond a mass of sun-cracked mud from end to end, with the exception of the above-mentioned well. The pond in which you got your specimens also goes quite dry, at least on the surface."

BEHAVIOR OF A PAIR OF LEAF-FISH, *Monocirrhus polyacanthus* Heckel

C. W. Coates

Illustrations from photographs by S. C. Dunton.

On Friday, March 17, 1933, the Aquarium received from Mr. Carl Griem, a professional fish collector, three specimens of the curious leaf-fish, *Monocirrhus polyacanthus* Heckel. These were three of the first five specimens ever brought into this country. Their habitat is the smaller streams and tributaries of the Amazon, and their habits would indicate that they are only at home in water which is always quiet and still.

The leaf-fish returning to its eggs after a foray to the other side of the aquarium. The eggs are to the right of the fish which, while facing the other way, drifts rather rapidly and in a straight line, backwards and sideways, to its charges.

The common name of the fish is a tribute to its peculiar color and methods of swimming. The color is a monotone of dead brown; the pectoral fins and parts of the dorsal and anal fins are quite transparent. Its method of progress, on the face of it, appears very mysterious, for hanging head down in the water the fish lies at an angle for all the world like a dead leaf, and drifts about at the whim of every little current of water. The compressed form of the animal heightens the illusion and the "beard," a slender tab of flesh on the chin, completes the dead leaf appearance by its simulation of a stalk. The photographs illustrate this very clearly.

Mr. Griem informed us that he had to examine closely numberless leaves before he found any of the fish, for so close is the resemblance of one to the other that it is not possible to distinguish between them without a careful scrutiny. However, when the fish chooses, it can move with astounding rapidity, jumping several inches from the water with little effort. An examination of the fins explains the anomaly. The pectoral fins, and dorsal and anal fin-tips are quite colorless and are in constant motion. They cause a considerable current of water to flow, but so nicely are their effects balanced that the fish can remain absolutely motionless in a small current of water; or the combined effects of the fins will drive it through the water in a swift dash. The movement of the fish should be remembered as it will be referred to later.

The leaf-fish is carnivorous, and subsists, seemingly, solely upon living fish of a suitable size. These are apparently deceived by the motionless leaf-like appearance, allowing the fish to drift, by well regulated movements of the

transparent fins, to within a few inches of it, when suddenly the end of the slowly moving leaf opens—a swift dart of the same leaf, and the little fish is interred within the larger one. In proportion to the size of the fish, the mouth is very large and evidently can form a strong inflowing current, for the small food-fish seems to be quite helpless to evade the yawning jaws, and in one gulp disappears entirely.

While the fish itself is interesting in the extreme, its spawning is still more so. Two of the three fishes mated within a week of their acquisition. The third died, probably having been destroyed in the pre-nuptial activities of the mating pair. As the initial spawning took place during the night, we had no idea of what occurred; that is, we did not see any fighting at all but we did see, early on the following morning, one fish by itself in the furthest corner from the other, this latter hanging motionless by a leaf of Sagittaria towards the back of the tank. On the slightest movement of the first fish away from the corner, the second opened its jaws in a most threatening manner and swam over, driving the first fish before it back to its corner. Such unneighborly behavior, in the fish world, usually implies eggs, so after a little examination of the aquarium in the vicinity of the leaf where the second fish had taken up its position, we discovered a number of transparent eggs hanging from the underside of the leaf. These were hanging at the end of individual stalks, each about the length of the diameter of the eggs, and seemed to be in constant motion, moving in more or less regular waves. The current from the fins of the fish stationed nearby was responsible for this, and it was apparent that the stalks of the eggs were being turned and twisted about themselves, by the ceaseless flow of water, to such an extent that after an hour or two many of the eggs seemed to be in clusters at the end of a common stalk.

The terrific mouth of the Leaf-fish, opened in a yawn, or perhaps a threat. The fish, which is compressed, seems to extend its mouth both upwards, which is to be expected, and sideways too. The eggs are in evidence here, on the leaf above and to the right of the fish.

Since the fish is so rare, and as absolutely nothing is known about its breeding habits, this occurrence opened up a number of possibilities and necessitated a certain amount of cogitation. The eggs could be taken away from the fish, for examination into their structure and the stalk to which they were attached, which is an important biological question, or the eggs could be left with the fish in an effort to see how long they took to develop, and how, if at all, the parent fish looked after them. This, too, is an important question. Both could not be done at once

A pair of Leaf-fish with eggs. The mottled appearance of the fish to the right seems to be characteristic before, during and after spawning. The eggs may be seen in a cluster hanging from the leaf just above the nose of the fish to the right. The clear golden-brown of the fish to the left of the picture is the normal coloration at times other than at breeding.

and the fact that we were not sure that the eggs would develop at all in the waters of an artificial aquarium had some bearing upon our reasoning. Against this we had to offset the importance of having a few specimens of this species alive in our collection, and since the fish is so rare in North America it was reasonably argued that it is perhaps of a somewhat delicate constitution and does not live long. We decided, however, to leave the fish with the eggs and see if we could raise a few young ones.

Our calculations were almost completely upset in this regard because the fish, hanging so motionless in the aquarium, made many of our visitors doubt that they were alive, and occasioned a constant tapping on the glass in an effort to ascertain the nature of these dead leaves. So much so, indeed, that the fish were almost frightened to death. At least they were sufficiently scared to lose their appetites. However, in spite of all these difficulties, during the fourth night after spawning the eggs hatched, and the threatening gestures of the parent fish nearest the eggs toward the other parent, increased to such an extent that it was deemed prudent to remove the now useless fish.

A few of the babies were still resting upon the leaf to which the eggs had been attached, but the majority of them were on the sandy bottom of the aquarium immediately beneath the "nest." A few more were scattered about the tank, but most of these were lying on the sand too. The parent fish left in the tank made no effort to round up these wanderers, but still stayed by the "nest", fanning the empty shells which could be observed on the leaf. This continued for a day, when the second parent was removed, for it did not seem to be of any assistance to the fry and it was necessary to feed it. This was difficult to do in the original tank for we did not know whether the fish would eat anything or not and it was risky in the extreme to throw into the same tank with the babies a few living fish; for these would undoubtedly eat at least some of the babies before they in turn were eaten. The removal of both parents, however, did not seem to interfere in any way with the growth of the youngsters which within a day or so of hatching lost their yolksac and readily took small Daphnia. This neglect of the young immediately after their hatching is interesting. Other species of the same family will care for the helpless fry for several days before completely ignoring them.

The parent fish were placed together again, and after one or two days of amicably drifting around the aquarium, one of them was observed fanning and scraping a leaf of the same kind of plant as was used before. This was closely observed and we saw that the fish would lie under the leaf and then swim backwards, drawing its back along the leaf. At this time the other fish, which stayed nearby but apparently evinced no interest in these proceedings, was the same dead brown color as when it arrived. The fish working at the leaf was entirely different, however. It was generally a lovely golden-tan color, with a few mottlings of dark brown.

After several hours of scraping and fanning the leaf, the fish came together and a number of eggs were spawned. It was then observed that the fish which had been so industrious about cleaning the leaf was now the outsider, the other taking complete charge of the eggs and again driving the first one away. This fish was the same that had nursed along the first batch of eggs. The color pattern had changed too. The fish which was so bright before was now the dead color, the fish with the eggs assuming the golden hue. Whether it was the male or female we do not know for both fish look exactly alike, but in the battle previously referred to, one of the fish had lost its beard and for this reason was identifiable. This particular fact is interesting for, again, in the other members of the family, it is the male which selects the site for the nest and which also looks after the eggs.

With such an immediate and favorable response to our attentions in the matter of housing and food, it may be suggested that the fish is not particularly delicate, its rareness being entirely due to the fact that it had never been brought into the country before. The lack of inhibitions regarding spawning, and the availability of the eggs, make the fish one which is very suitable material for experimental investigations.

Echinoderm Enemies of Fishes

How Starfishes and Sea Urchins Catch and Eat Fishes

E. W. Gudger
Bibliographer and Associate in Ichthyology
American Museum of Natural History

Introduction

TO the naturalist, probably the most interesting things in the lives of animals are their relationships, friendly or inimical, with those animals with which they are intimately associated. As a student of animals at the sea shore for many years, I found my greatest interest in their unusual structures, associations and habits, particularly those of fishes. Of later years, as a bibliographer of fish literature, I have collected great numbers of references to these out of the ordinary matters, among them accounts of unusual enemies of fishes. Some of these have from time to time been brought together in unified form in various articles, others are projected.

With regard to the invertebrates under consideration, I have long known that the various classes of Echinoderms harbored either internally or externally, as symbionts or probably more correctly as inquilines, fishes of the family Fierasferidae. That they are sometimes inimical to fishes I have found in the last few years on cataloguing various articles in which they are described as attacking and eating fishes. Interestingly enough each author thought his observation an isolated one, since none seemingly knew of the observations of anyone else.

Starfishes Attacking Fishes

Recently my attention has been called to the earliest account of all, one written twenty-six years ago but which, buried in a large paper on the behavior of a starfish, had escaped me. With it and the other accounts at hand, and since this habit is as interesting as it is unusual, it has seemed worth while to bring all the various observations together into a short paper under the title set out above. Perhaps this article may serve as an incentive to others to put similar observations on record.

It is well known that starfishes feed on live mollusks such as whelks and oysters—in fact they are great pests to the oyster planter. It is also commonly understood that they are scavengers, feeding among other things probably on dead fishes. That they also capture and feed on live fishes was first made known, so far as I can ascertain, by Prof. H. S. Jennings in 1907.[1]

Fig. 1. A starfish has caught a living fish, is holding it with the pedicellaria and tube-feet of one arm and is moving it toward the oral aperture. From an unpublished photograph by Prof. H. S. Jennings.

For study of the behavior of *Asterias forreri,* a Pacific coast form, at the laboratory of the Marine Biological Association at La Jolla, California, large numbers of starfish were kept in aquariums and their feeding habits observed. They were forced to feed on a variety of animals in order to test such habits. Since this is the first account of their catching and feeding on live fishes, and the only one of their catching fully active fishes, it will be well to quote Jennings verbatim. He writes that:

"It seems surprising that the starfish can capture such active, swift animals as fish. But

in our tanks this often occurred. They captured and devoured fish having a length equal to the diameter of the starfish, from the tip of one ray to the tip of the opposite one. In one of our tanks a large number of starfish crawled about over the sides and bottom. At times numbers of fish of various sorts were kept in this tank, and it was soon found that the starfish were capturing them. The fish, swimming about, seemed to have no mistrust of the brown patches on the walls; when frightened they would even attempt to conceal themselves upon or against the starfish. The tail or a fin strikes in its motion the surface of the starfish. At once the rosettes rise, the pedicellariae open, and when the edge of tail or fin comes against them anew, it is seized by a hundred little jaws. Of course the fish gives a leap and attempts to pull away; the jaws hold, the fish struggles, and in struggling strikes other parts of its body against the starfish. Wherever there is a thin edge of fin, tail, or gills, the pedicellariae seize it, and the fish soon finds itself held tightly. Now the tube feet extend, the cruel suckers plant themselves over the smooth surface of the body, and the fish is transported to the mouth. In all cases observed it was the tail that was first brought to the mouth. The lobes of the stomach then come forth, press themselves against the tail and proceed to digest it, though the fish still makes at intervals violent efforts to escape. In the course of six or eight hours the posterior one-fourth of the body of the fish was usually quite digested, and the remainder of the fish was dropped. Figures 5 and 6 show photographs of the capture of fish by the starfish."

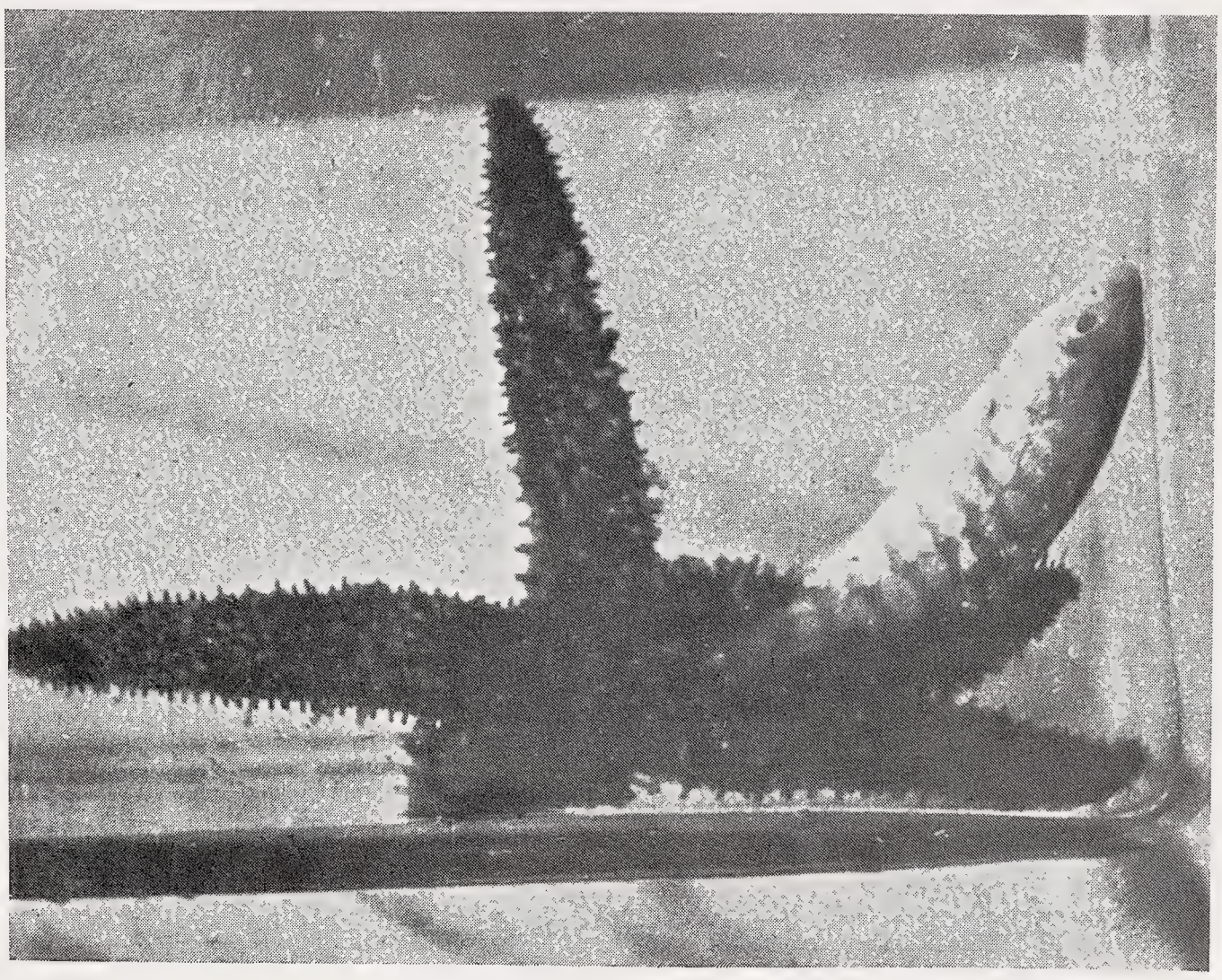
Through the kindness of Professor Jennings, I am privileged to reproduce his illustrations as my figures 1 and 2, and also to publish (figure 3) a third photograph never before utilized. So far as I know these are the first figures and indeed the only photographs ever published showing this remarkable capture of food on the part of a starfish.

Not all fishes were equally readily attacked by the starfish. Those with which it was more or less associated out in the ocean did not seem to be in danger, but other forms were liable to be seized. Here follows Jennings' statement as to this interesting discrimination:

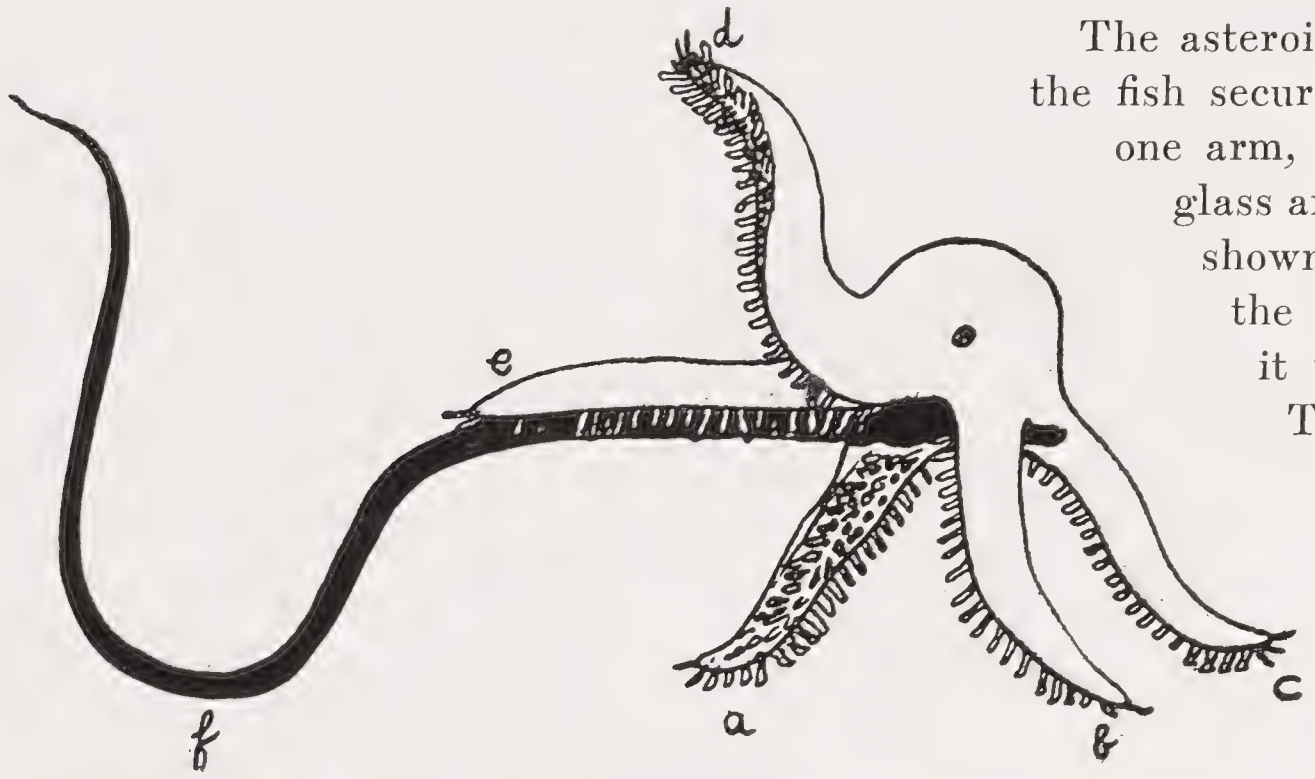
"When there were placed in the starfish tank fish that in their normal existence spend their time swimming about in the open water, not coming against stones or other objects save when they attempt to hide from actual danger, these were readily caught by the starfish. When these fish came in contact with the animals, their movements were strong, sudden, incautious, so that the pedicellariae were soon roused to attack. But

Fig. 2. *Upper*. The starfish is beginning to ingest the living fish tail foremost.

Fig. 3. *Lower*. The fish is now almost half ingested by the starfish. Note how the tube-feet are holding it fast. From photographs by Jennings, 1907.



the fish that in their normal existence live in rocky pools and under stones, resting much of the time against the surface of the rocks, were not captured by the starfish. Such fish are very abundant about the shore, and many of them were kept in the tanks with the starfish. Such fish frequently came against



the starfish, resting upon it or hiding behind it as if it were a stone. But their movements were so gentle and deliberate that the pedicellariae were not roused, and such fish were not seized."

In 1915, H. N. Milligan, keeping starfishes and various syngnathid fishes in the same aquarium at the Horniman Museum (?) in England, three times saw the starfishes attack and eat three different kinds of pipefishes—fishes covered with hard horny plates and hence not ordinarily eaten and probably avoided as prey by most other fishes. The first account[2] records how two starfishes caught and ate nearly dead specimens of the aequoreal pipefish.

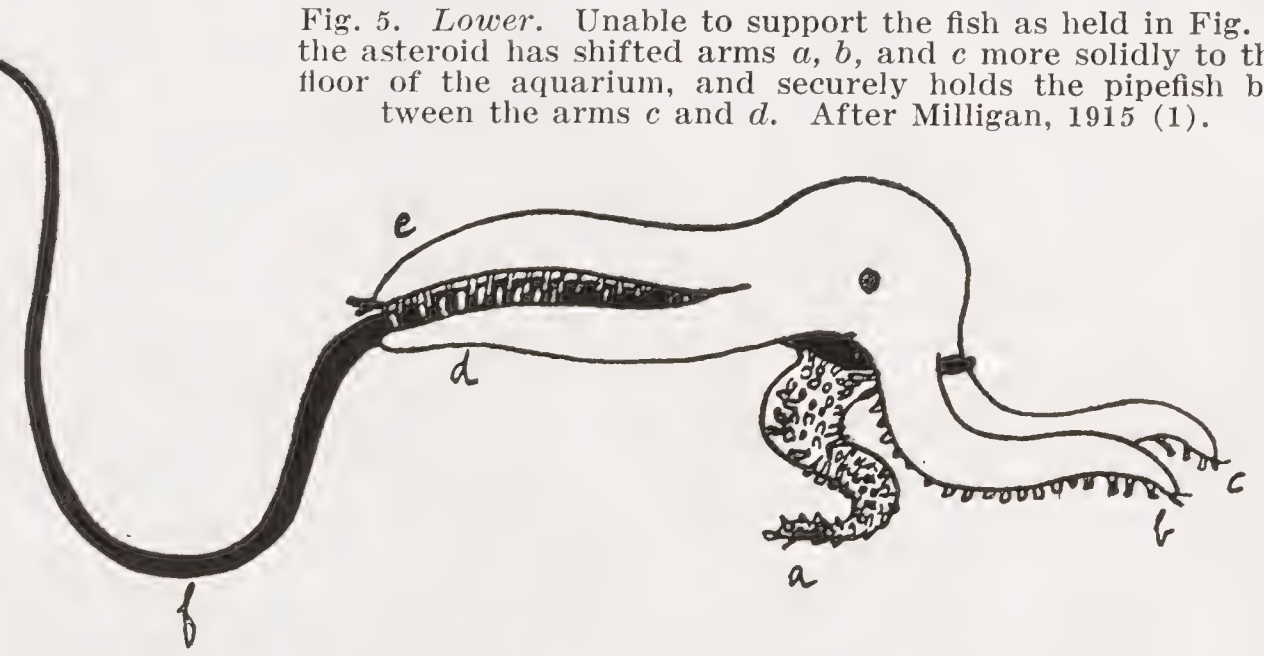
Two medium-sized healthy starfishes had been kept in an aquarium for several months. In with these were placed two active broad-nosed pipefish (*Siphonostoma typhle*) and two of the aequoreal species which were half dead. One of the latter fell near one of the starfish. This (not fed that day) at once moved over to the pipefish, placed itself over its head, which was the first part it touched, and humped its body as if about to feed. The starfish handled its ten-inch prey in the following fashion; supporting itself on three arms (see fig. 4 herein) *a, b,* and *c,* and holding fast to the glass front of the aquarium with the fourth (*d*), it laid hold of the fish with arm *e* (the fifth), the stiff bent body of the pipefish resting at the bottom at *f*. The arm *e* was laid parallel with the body of the fish, which was held fast by the encircling tube-feet.

The asteroid was apparently not able to hold the fish securely enough with the tube feet of one arm, so it disengaged arm *d* from the glass and with it laid hold of the fish as is shown in figure 5. Held thus securely, the fish offered no resistance, indeed it was probably dead by this time. The starfish then partially everted its stomach and wrapped this around the body of its prey. Digestion evidently went on through the night, for next morning, the anterior end of the fish was bare of skin and flesh and the asteroid had shifted toward the tail of its prey.

In the meantime the second starfish had been at work on the second *Nerophis* and over certain areas had completely skeletonized this fish clad in horny buckler-like plates—this in about sixteen hours. Tiring, it then moved over to where the pipefish number 1 was being eaten by starfish number 1 and laid hold of the tail of this *Nerophis*. However, it did not stay here long.

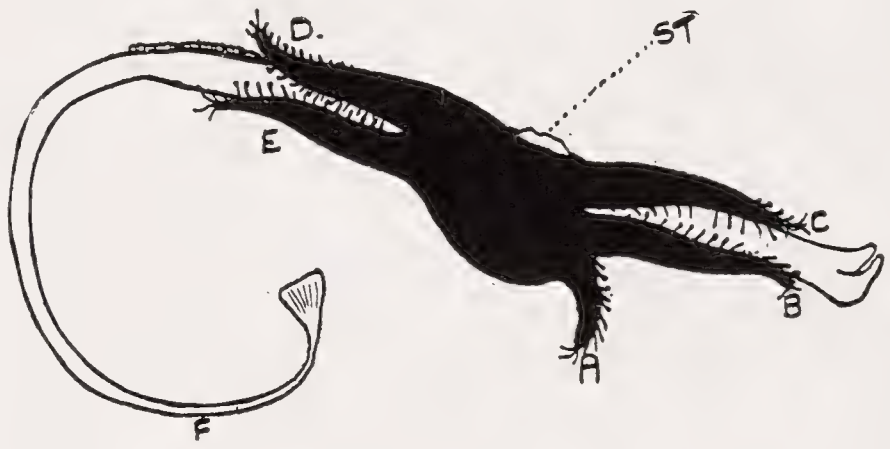
Fig. 4. *Upper.* A starfish, supporting itself by the arms *a, b, c,* and holding fast to the glass of the aquarium with the arm *d,* has laid hold of a half-dead pipefish (*Nerophis aequoreus*) with the arm *e*. The body is humped up preparatory to everting the stomach on the head of its prey, which is partly supported on the floor at *b*.

Fig. 5. *Lower.* Unable to support the fish as held in Fig. 4, the asteroid has shifted arms *a, b,* and *c* more solidly to the floor of the aquarium, and securely holds the pipefish between the arms *c* and *d*. After Milligan, 1915 (1).



Contrasted with the behavior described above, it is interesting to note that though the starfishes actually walked over the bodies of the healthy pipefishes, these were for some reason not attacked.

A month later Milligan[3] put a sick broad-nosed pipefish into the aquarium with the same starfishes. This specimen, 12 inches long by five-sixteenths of an inch broad and three-eighths of an inch deep, was larger and more difficult to handle than the smaller fish referred to in the preceding account. One asteroid, however, in order to hold it fast, grasped it as shown in figure 6. It held the fish with the tube feet of four arms, anchored itself to the side of the aquarium with one arm (A), and, with its body humped up and its stomach (*st*) partly everted, began to feed on its prey. Apparently the fish was too heavy a load for the asteroid to support. It presently disengaged arm D and with it laid hold of the aquarium, in the meantime curling arm E about the pipefish so as to hold it about as securely with one arm as with two. (See figure 7 herein).



Then a surprising thing happened. The second starfish seemed to smell the pipefish at a distance of two feet, for it (white) travelled directly toward this and settled itself on top of starfish number 1 (black) as may be seen in figure 8. This so amazed the latter that it left the fish and retreated to the floor of the aquarium. However, it presently returned and laid hold of the prey. Asteroids and fish then fell to the floor of the aquarium, where they assumed the position shown in figure 9. Starfish number 2 (in white) though smaller than number 1 was certainly more aggressive, as was again shown by its again driving number 1 away.

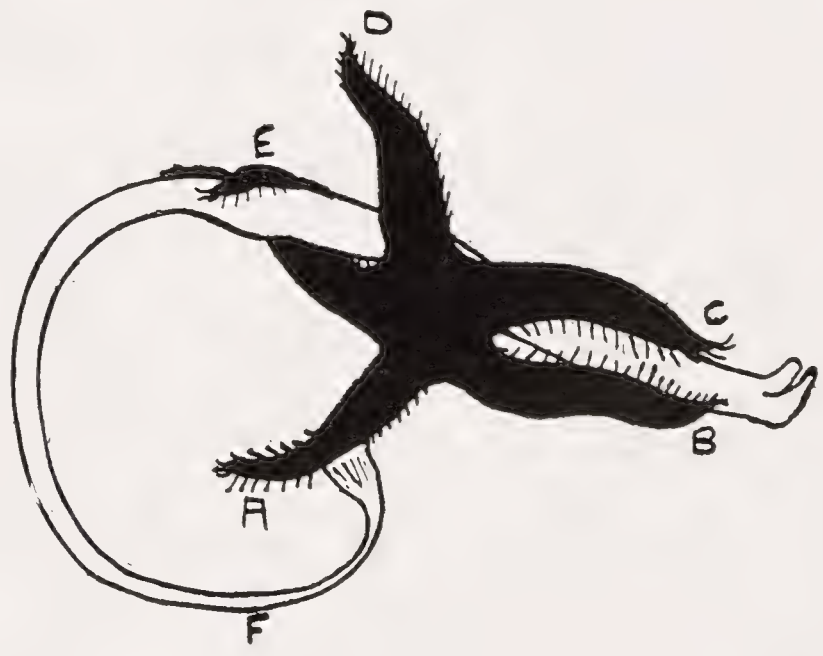


Fig. 6. *Upper.* Another starfish in a later experiment has laid hold of a great pipefish (*Siphonostoma typhle*) with the four arms, *b, c, d,* and *e,* in pairs, while it supports itself on the arm *a.* The stomach, *st,* is partly everted. The tail of the fish is on the floor, *f.*

Fig. 7. *Lower.* To support itself better while feeding on the fish, the asteroid is bracing itself with arm *d,* as well as arm *a.* Note how arm *e* is curled around the fish. After Milligan, 1915 (2).

Finally, the pipefish had to be removed since the water was becoming foul. This fish, however, was not so well cleaned off as the smaller form had been. Probably its bucklers were thicker, and then too the asteroids had so disturbed each other that neither had been able to press its stomach closely enough and long enough to carry digestion very far.

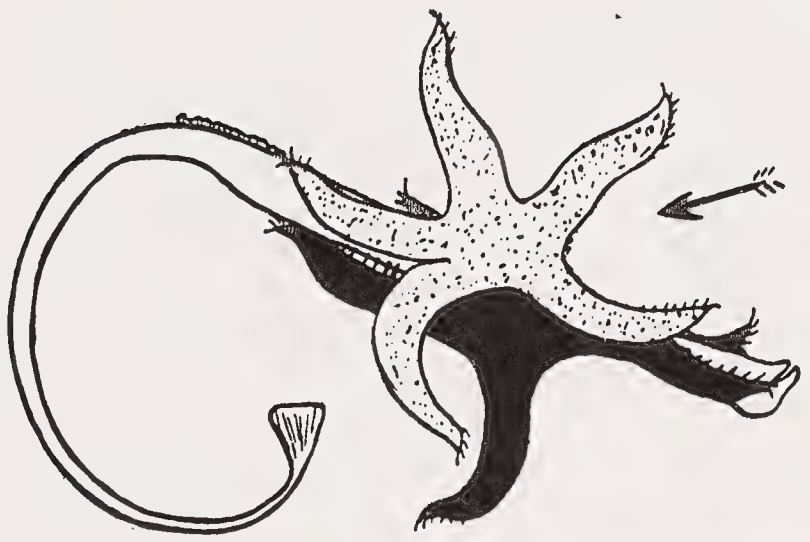
The accounts just given are of attacks by starfish on sick or half-dead pipefish of rather small size. But some months later, Milligan[4] gave a brief account of how a starfish made an attack on a strong and vigorous great pipefish eighteen inches long. Perhaps it will be well to let the author describe in his own words what took place:

"The pipefish, which threw its body into vigorous contortions when it was taken in the hand, was dropped into an aquarium containing two starfishes, as it was not deemed possible that the latter could or would attack so large and strong an animal. The pipefish, as it fell through the water, passed a starfish, which was clinging to the vertical rockwork of the aquarium. When the fish reached the bottom it lay still, perhaps a little fatigued with its four hours journey in a collecting can from the coast. The starfish, which was about six inches away, almost immediately began to descend quickly and directly towards the fish, with the slender terminal tube-feet of its foremost rays waving in the water in the manner characteristic of these tube-feet when the starfish is advancing towards food. When the starfish reached the pipefish it moved upon the latter in such a way that it embraced the whole head and fore-part of the fish with two rays. The pipefish did not move until the starfish had affixed a number of tube-feet of each ray to its body. The pipefish then gave several violent jerks, but to the astonishment of myself and another observer it was unable to get free. The two animals were lifted out of the water and separated, the pipefish being placed in another aquarium."

The next account of this extraordinary behavior on the part of an asteroid is from the pen of Professor F. E. Chidester.[5]

One morning at the Marine Biological Laboratory at Woods Hole, Massachusetts, he observed an *Asterias forbesii,* with rays eight centimeters long (2.25 inches) which had attacked

a full-grown *Fundulus* ten centimeters (4 inches) long. It grasped the fish with the tube feet of two rays, while it held on to the wall of the aquarium with those of the other three. The body of the starfish was humped up about one



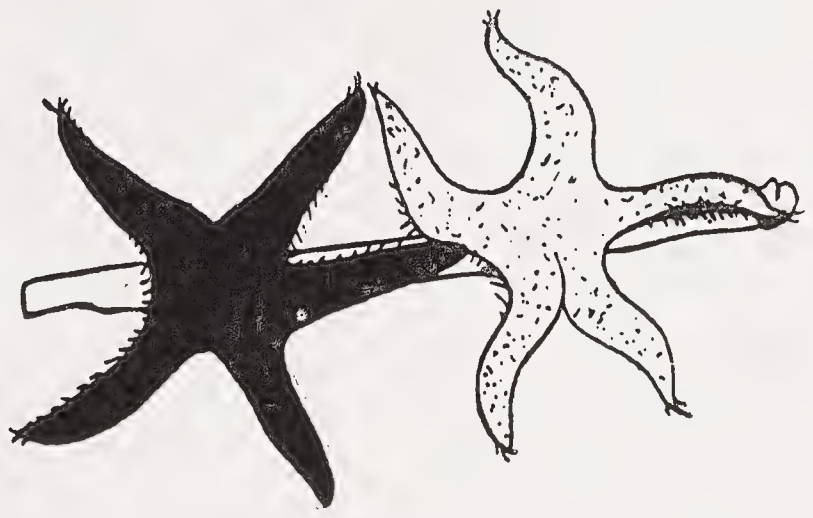


Fig. 8. *Left.* A second starfish (in white) is disputing with asteroid No. 1 (in black) for possession of the prey.
Fig. 9. *Right.* The two starfish have compromised their contest for the pipefish and the newcomer takes the head. After Milligan, 1915 (2).

and a half centimeters (0.6 inches). The head of the fish was ingested by the everted stomach of the asteroid which covered about two centimeters (0.9 inch) of it. In preserving the two animals, the stomach was partly withdrawn but even then the head of the fish was held firmly in the mouth opening of the starfish. The asteroid must have caught the fish during the night and Chidester thought that the fish must have been a dead one since he could hardly conceive the starfish's catching a live *Fundulus*.

Notice should here be called to the fact that the asteroid took in the fish head first, whereas Professor Jennings' starfishes always operated on the tail as shown by his photographs. Why this difference in behavior, is a question which cannot be answered. Furthermore Jennings' starfish caught live, active fishes and then ate them.

Sea Urchins Feeding on Fishes

Starfishes are after all pretty active animals, comparatively speaking; but their near relatives, the sea urchins, almost round and encased in an inflexible exoskeleton are much slower and more unwieldy in their movements. But despite their handicaps they catch and eat fishes, as will now be shown.

This was, so far as I can ascertain, first made known by Milligan, who, as seen, has carried extensive studies on the feeding habits of echinoderms. Having previously observed that sea urchins had settled down on and had apparently tried to eat the eggs of the sea-bullhead, *Cottus bubalis,* he made more definite experiments covering three years, and reported his results in 1916[6]

The following species of fishes died in his aquariums and were devoured wholly or partly by the purple-tipped urchin: *Echinus miliaris;* the striped wrasse (*Labrus mixtus*), common goby (*Gobius paganellus*), gattorugine blenny (*Blennius gattorugine*), and plaice (*Pleuronectes platessa*). The sea urchins ate fins, flesh, and viscera of these fishes. These were dead fishes, but if dying ones were caught they were tenaciously gripped and were eaten. Perhaps it will be well to let Milligan describe in his own words a typical case as follows:

"A striped wrasse of forty mm, in length, which was thought to be dead, was removed from an aquarium in order that it might be used as food for the sea urchins. When, however, the tail of the fish was thrust beneath the body of one of

Fig. 10. A *Fundulus* is being held against the glass front of an aquarium by two sea-urchins (*Arbacia punctulata*) which are devouring it head and tail. After Parker, 1932.

the sea urchins, 38 mm. in diameter, which was clinging to the vertical side of the aquarium, the fish suddenly began to struggle. The sea urchin held it tightly by pressing a number of spines not only around but also upon the body of the fish, those spines which were pressed on the prey being used with such effect that they made deep indentations in its body. The sea urchin now raised one part of its body from the side of the tank, and with spines and tube-feet gradually urged its prey towards the mouth, the fish, in spite of several efforts, being unable to get free. As soon as the prey had been brought into such a position beneath the mouth that the teeth could conveniently work upon it, the sea urchin attached a number of tube-feet to, and also pressed spines upon, the side of the tank in such a way that the victim was imprisoned as in a cage. The sea urchin remained for several hours upon the wrasse, of which it ate about a third part, afterwards allowing the remainder to fall to the bottom of the aquarium."

The only other observation known to me was made on this side the Atlantic by Professor G. H. Parker,[7] after noting that the sea urchin is generally considered a scavenger, feeding on dead plants and animals on the sea bottom, says that ". . . it is not always limited to so tame a diet. Occasionally, it rises in its quest for food to almost sportsmanlike activities."

Here is Professor Parker's account in his own words, and here is his figure showing how the echinoid acted.

"If a number of sea urchins are put in an aquarium in which there is a goodly supply of mummichugs, *Fundulus heteroclitus,* one or more of these fishes may be caught and eaten by the sea urchins. The capture usually takes place at night, and the prey is almost always a partly spent fish. I doubt if a fully vigorous *Fundulus* is ever taken by a sea urchin. I have never witnessed the first steps in the capture. What I have seen, on first arrival, is a fish, usually a small one, whose head or tail is largely covered by the sea urchin. The spines and ambulacral feet of the captor are used to hold the prey against either the bottom or the sides of the aquarium, while the jaws of the sea urchin are vigorously plied on the flesh of the fish. Not infrequently, a fish once caught is beset by a second sea urchin and the two together complete the demolition of the *Fundulus,* as shown in the accompanying figure. The fish, when caught, often offers some resistance, but it soon succumbs to the sea urchin as though it had been poisoned by its captor. However, I have no direct evidence that the sea urchin can exert such influences. The main point that this note is intended to record is the capture of live fish by the sea urchin, *Arbacia punctulata.*"

Summary

(1) There are brought together herein accounts of thirteen echinoderms feeding upon fishes.

(2) Eight +* of these pertain to the feeding activities of starfishes, five + to sea urchins.

(3) In several cases the starfishes caught and ate live active fishes. In most cases, however, they caught sick or dead fishes. The fishes caught by the sea urchins were also at least partly disabled.

(4) Echinoderms must (in some circumstances at least) be classed as enemies of fishes.

*The sign + means that in addition to statements of definite attacks by echinoderms, others were indicated but not definitely enough to be counted.

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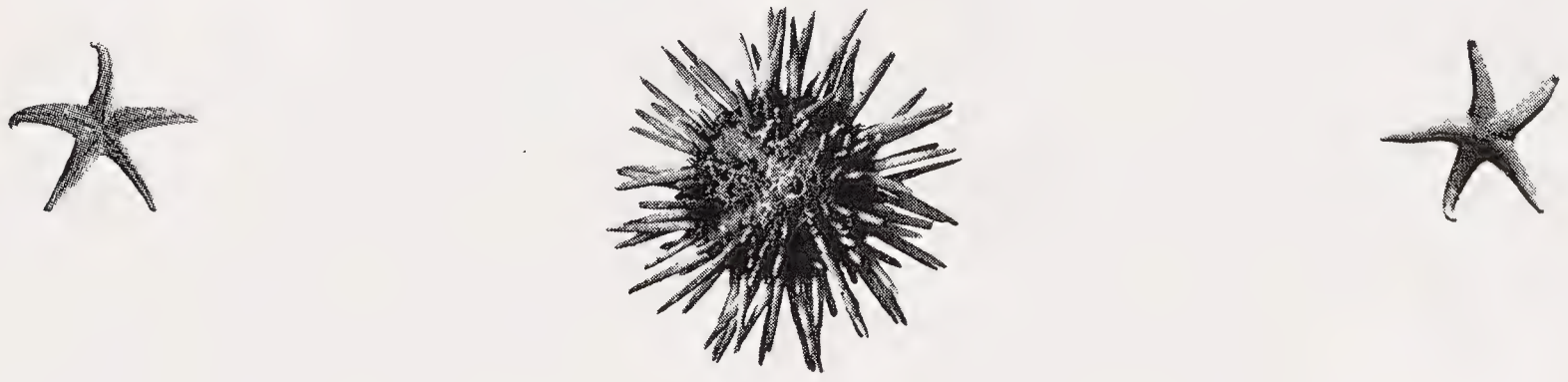
[7]Parker, G. H. On Certain Feeding Habits of the Sea Urchin, *Arbacia*. Amer. Nat., 1932, 66, 95-96, text-fig.



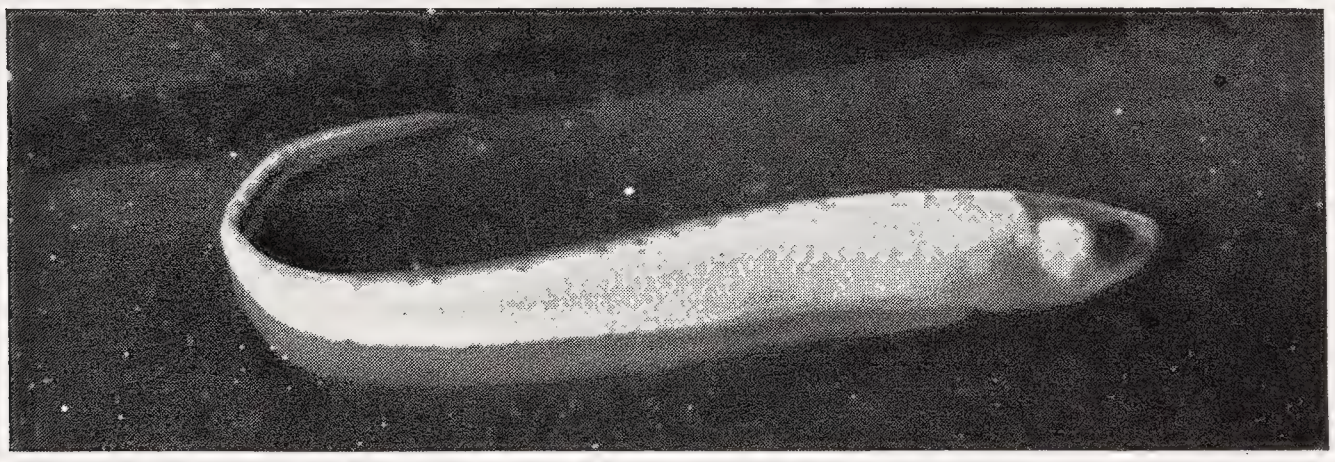
The Barracuda, illustrated in the Bulletin for July-August, 1932, continues to thrive, and since that photo was taken has more than doubled in length. If this rate of growth continues for any time it bids fair to become one of the Aquarium's larger exhibits. The length is about two feet, two inches. The maximum size for this species is about six feet. Photo by S. C. Dunton.

A PEARL FISH FROM NASSAU

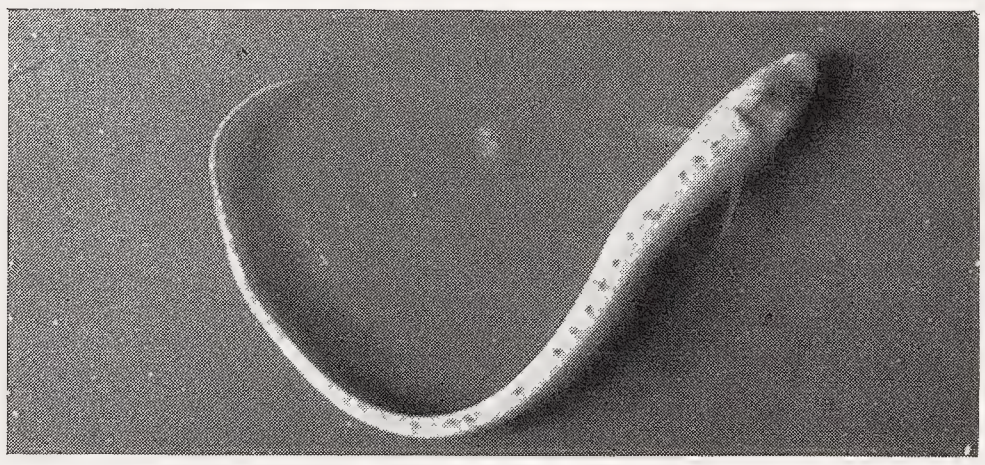
C. M. Breder, Jr.

WHILE waiting for supplies preparatory to the second Andros expedition, previously discussed, some time was spent at Mr. Bacon's Nassau residence. This place, known as Pirate's Nest, is an island forming part of the seaward side of Nassau Harbor.

In rough weather various samples of the sea bottom, such as shells, corals, sea-fans and the like, are cast up on the beach. Consequently, after a storm or heavy sea, a stroll along the shore line is always of interest. On one such occasion a large holothurian, or sea-cucumber, was thus found. These creatures are little more than long, softish tubes and although related to the starfishes show few superficial resemblances. They are not attractive animals but in certain quarters are much valued as a delicacy. They are known to commerce in the Orient as trepang and to the French as beché de mer.



The Pearl Fish, *Carapus bermudensis*, found at Nassau. Side and top view.



It so happens that a small fish uses the body cavity of these animals as a refuge, entering tail first into the rear opening of the sea-cucumber. Ordinarily one may examine a great many of these sluggish creatures without finding a single pearl fish, as they are sometimes called. The case in question was thus somewhat of an exception as a glance revealed the head of such a fish protruding as if to look around at the exceptional environment in which it suddenly found its home. A slight pressure on the side of the expiring sea-cucumber caused it to contract violently in such a fashion that it ejected its recent tenant with sufficient force to propel it for a distance of over five and one half inches (139 mm. in total length) and showed the following appearance, the description of which is transcribed from notes made at the time. The fish appeared to be much smaller than it actually was, as the flesh was quite transparent and glass-like. The outlines that were noted were those of the skeleton. The true bodily limits of the fish could only be seen by viewing it from certain angles. The vertebral column was notably evident as it was heavily pigmented with a Van Dyke brown. Radiating from this, many of the numerous haemal and neural spines were similarly colored. This coloration presented no pattern or regularity whatever. The rest of the body was quite transparent, save for the head and vital organs. The former was suffused with bronze while the peritoneal covering in addition had marked silvery reflections.

This fish, *Carapus bermudensis* (Jones) has been recorded from Florida, Cuba and various Bahama localities and is usually taken in the cavities of sea-cucumbers or large marine molluscs. So far as known it uses these invertebrates merely as a shelter and is not parasitic.

A LOBSTER BURIAL

Illustrations from photographs made at the Aquarium by S. C. Dunton.

AN unsuccessful attempt to shed the shell resulted in the death of an Aquarium lobster. Such an eventuality is not unusual among crustacea, and there is doubtless a considerable mortality even in a state of nature whenever this periodic event occurs which is necessary to growth. The peculiar behavior of one of the tank mates prompted the accompanying photographic records. At the time of the demise another lobster proceeded to bury its unfortunate fellow. Both the cast shell and the lobster itself were included in the burial heap.

The explanation of this behavior, which the uncritical might like to consider anthropomorphically, seems to be that of protecting a reserve food supply. At least the related fresh water crayfish will at times bury pieces of aquatic plant and later, when they have decomposed, dig them up for food.—*C. M. Breder, Jr.*

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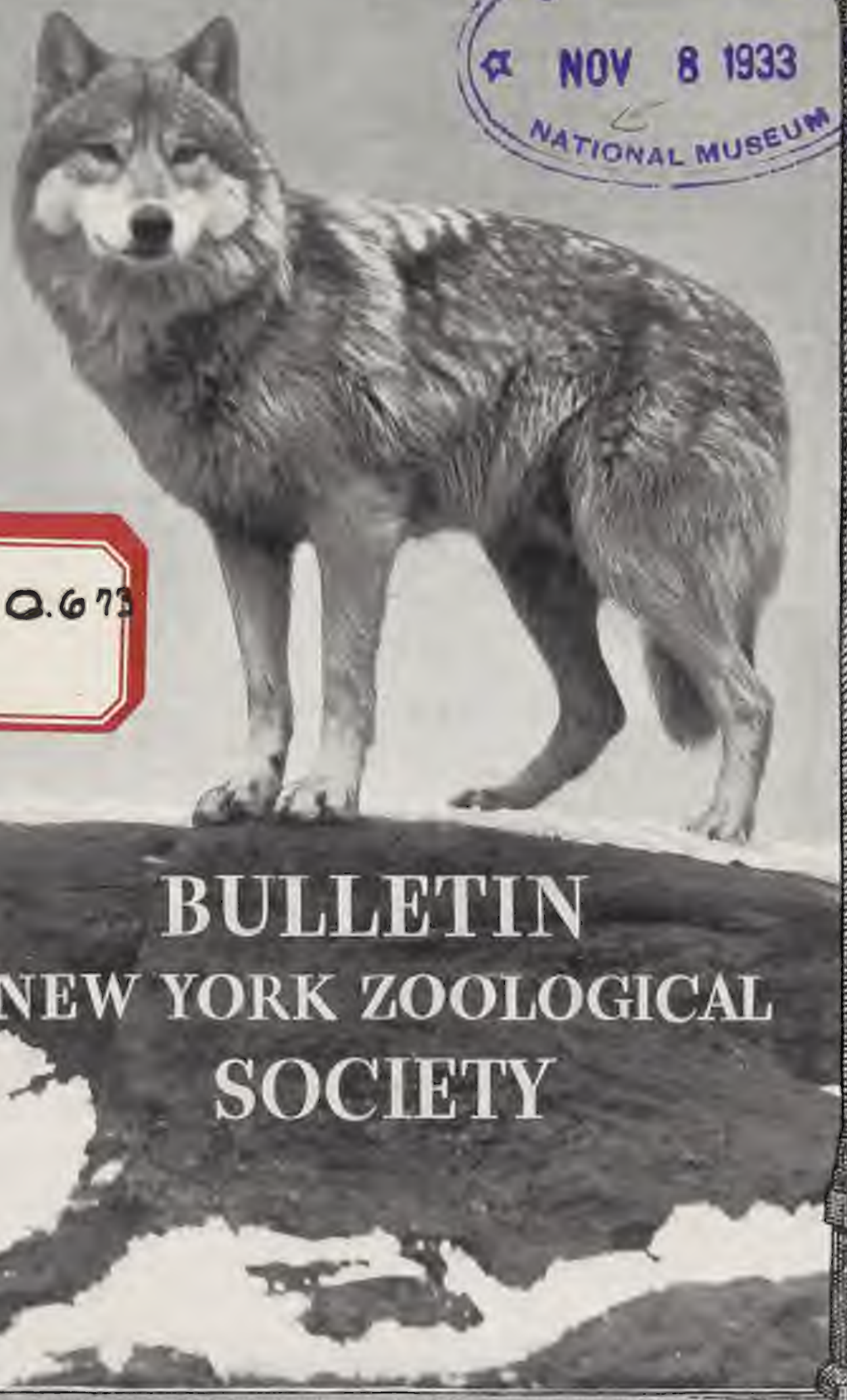

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Vol. XXXVI, No. 4 July-August, 1933

Contents

WILD DOG TYPES ..... *Frontispiece*

NATURE'S WILD DOG SHOW ..... *William K. Gregory* 83

Fig. 1. Great Grandfather of Dogs
Fig. 2. Russian Wolf-Hound
Fig. 3. Giant Dog, Restoration
Fig. 4. Evolution of Fossil Teeth

PRINCIPAL TYPES OF DOGS 87

Plates

Wolf Pups
Eskimo Dog
Dingo
Black-backed Jackal
Indian Jackal
Coyote
Timber Wolf
Raccoon Dog
Red Fox
Gray Fox
Swift Fox
Arctic Fox
Crab-eating Dog
Small-eared Dog
Cape Hunting Dog
Bush Dog

ON THE ANTARES TO THE WEST INDIES ..... *William Beebe* 97

Illustrations

The Antares at Sea
Tobago Keys
Martinique
St. Kitts
Martello Tower
Barbudan Village
Saba
Oysters on Mangrove Boughs
Spider Lily
Flyingfish Wing-fins
Reddish-winged Flyingfish
Dolphins
Devilfish
Anglerfish
School of Anchovies
Pacheca Forest

CRUISES OF THE ANTARES ..... Sketch Map—*John Tee-Van* 98
TIMBER WOLF ..... *Cover*

BULLETIN

NEW YORK ZOOLOGICAL SOCIETY

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1, Eskimo Dog; 2, Cape Hunting Dog; 3, Jackal; 4, Dingo; 5, Red Fox; 6, Coyote.

BULLETIN
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Nature's Wild Dog Show

WILLIAM K. GREGORY

Fellow of the New York Zoological Society
Foreign Fellow of the Zoological Society of London

Illustrations from photographs made in the New York Zoological Park unless otherwise indicated.

EVER since the Azilian phase of the Old Stone Age the dog has been devoted to man. In return for this devotion man has saved the dog from the extermination meted out to the wolf, who is practically the ancestor of at least the Eskimo dog, the "police dog" and related strains. Moreover, man has taken such pride in his dogs that from the time of Asshurbanapl the Assyrian, various breeds of dogs have been recognized and their points noted. Through thick and thin the dog-buying public has stood by the dog-breeders, who in the past few hundreds of years have produced creatures so amazingly different as the squat bulldog and the wraith-like borzoi.

A modern metropolitan dog show with its hundreds of entries and dozens of classes is a brilliant and imposing, even if fleeting, event. But Nature's dog show has been running steadily for millions of years, its stage, the world, its prizes, survival, its penalties, starvation and death. On the whole it has been rather a grim and grisly affair. Moreover Nature has cleverly run two vast shows at once, her dog-and-cat show on one side of the big tent and her horse-and-cattle show on the other, with no pens or barriers between. It has been great fun for the dogs, cats, lions and other flesh-eaters, but not so good for the peaceful herbivores, except that it has encouraged them to become fleet of limb and to develop defensive horns.

The mute records of this age-long pursuit and carnage, of this triumph of cruel and fleet predators, are now to be found in the museums of the world, where the skulls and bones of fossil carnivores and fossil herbivores have been gathered in from many a locality: from the Western States, from the Tertiary deposits of Europe, from the Siwalik Hills of India, from the caves and other surface deposits of Brazil, California, Ohio, England, Continental Europe, China, Java, and even from far-off Australia. These supplement the collections of skins and skulls of the numerous recent species of wild Canidae, which have been studied and classified by Huxley, Mivart,[1] Oldfield Thomas and later authors, especially Cabrera.[2]

The oldest fossil Canidae or members of the dog family are found in the Lower Oligocene of North America, their estimated age about thirty-eight million years. At that remote time the family, according to the late Dr. W. D. Matthew,[3] was already represented in North America by two genera: (1) *Cynodictis* (Fig. 1), the common ancestor of all the modern dogs, wolves, foxes, dholes, etc., as well as of the raccoon family, and (2) *Daphoenus,* the common ancestor of the giant dogs (Fig. 3) and the bears.

[1]Mivart, St. George. 1890. Dogs, Jackals, Wolves and Foxes: A Monograph of the Canidae. London.

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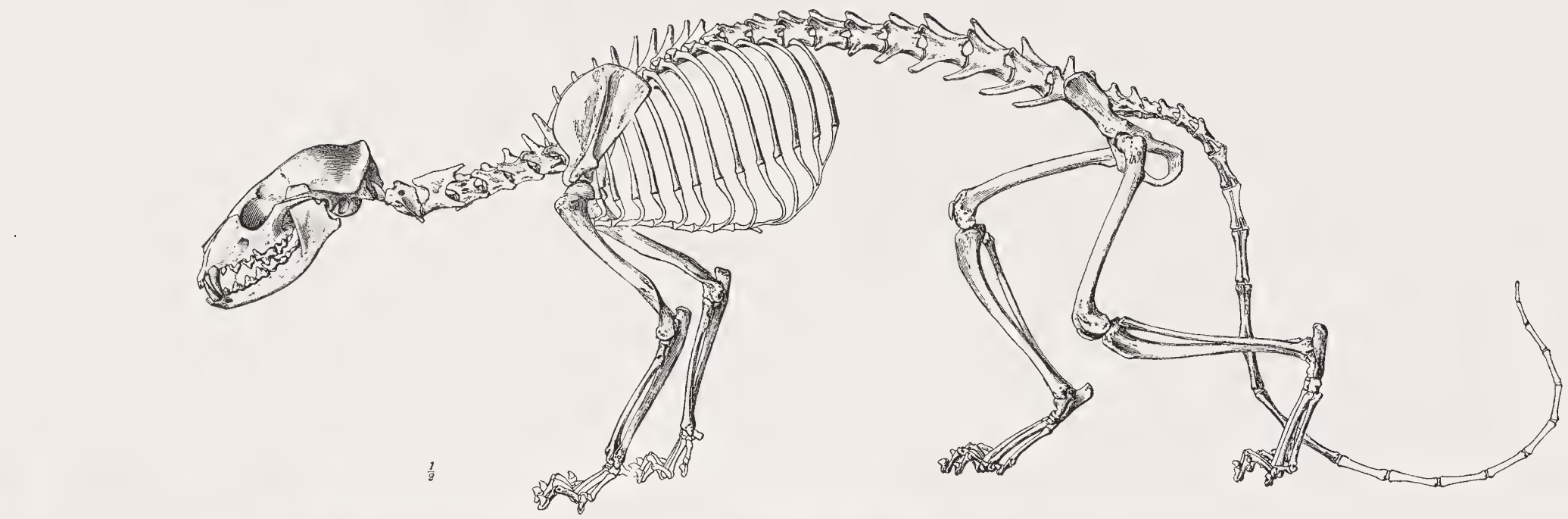
[3]Matthew, W. D. 1930. The Phylogeny of Dogs. Journ. Mammalogy, XI, No. 2, pp. 117-138.



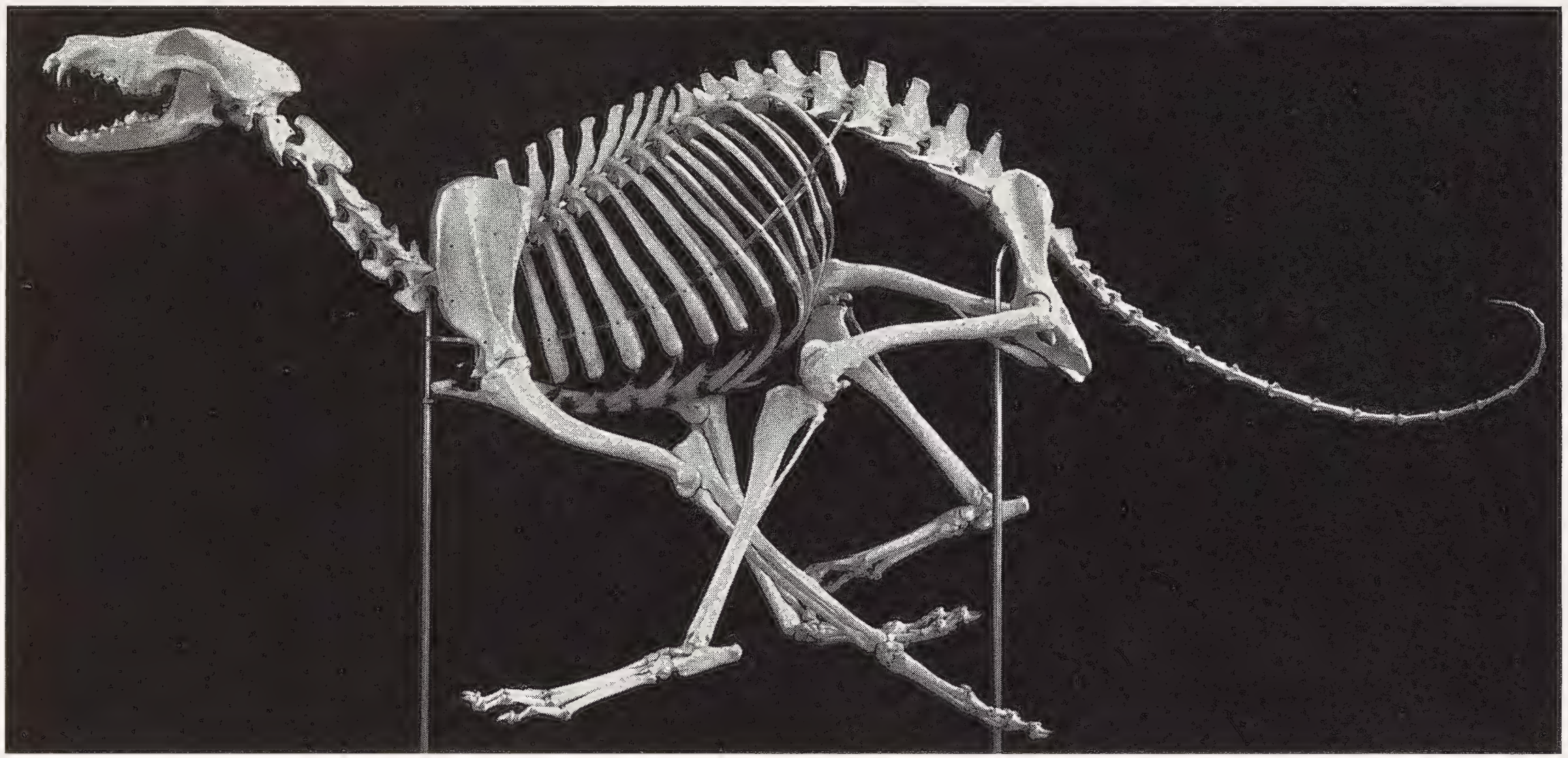


Fig. 1. *Upper: Cynodictis gregarius,* the great grandfather of the dog family. Restoration of a nearly complete fossil skeleton from the Oreodon Beds of Cedar Creek, Colorado. After W. D. Matthew, American Museum of Natural History. Fig. 2. *Lower:* Skeleton of Russian wolf-hound, illustrating extreme adaptation to swift running in a modern dog. Mounted by S. H. Chubb, American Museum of Natural History.

Cynodictis was not yet either a dog, a wolf, or a fox, and had somewhat of the long-bodied, slinking habit of the civet. Its feet were less compressed than in later dogs, the claws slightly retractile and more like those of a civet. The predecessors of *Cynodictis* in the Eocene of Wyoming had been still less dog-like. These were arboreal mammals, somewhat like a raccoon, with spreading hands and feet. In fact, the entire skeletal anatomy of the earliest known true carnivores, as interpreted by Dr. Matthew, indicates arboreal, forest-living habits. The fast-running dogs were evolved much later, as the plains replaced the forests in both Western North America and Europe.

Daphoenus, the contemporary of *Cynodictis,* had a more massive skull, with upper molars of the crushing type. The carnassial, or shear tooth, had a strong blade. The bears, according to Matthew, are only gigantic short-tailed dogs which have become secondarily plantigrade and have greatly increased the size of their crushing molars, while reducing their upper carnassials. The extinct *Hyaenarctos* of the late Tertiary of western North America, Asia and Europe, is regarded by many high authorities as tending to connect the bears with the dogs.

In the Miocene epoch (about twenty-odd million years ago) there were many genera and a still greater number of species of dogs, which by this time had become swift-running forms with narrow, compressed feet. One of the smaller Miocene dogs, *Temnocyon,* was regarded by Wortman and Matthew as at least a structural ancestor of the modern dholes, or wild dogs of India.

The steps by which these Miocene and Pliocene dogs gave rise to the numerous types of modern wolves, dogs, foxes and fox-like animals have not yet been satisfactorily worked out, but they are now being actively studied by a specialist whose report may be expected to confirm the relatively high geological antiquity of the phyla, or lines of descent, leading to certain of the modern genera.

Among recent Canidae the most difficult to determine with reference to their broader relationships are the various genera and species of South American dogs. For many millions of years South America was isolated and thus developed its own peculiar types of hoofed mammals and carnivores, all very unlike their distant relatives of the Northern World. But at the close of the Miocene age a land bridge with North America was established, hordes of immigrants from that country gradually seeped in and eventually crowded out the old South American mammals. Among these immigrants were members of the dog family; it is now evident that the numerous species of South American canids, which offer so many confusing resemblances to true dogs on the one hand and to foxes on the other, are "living fossils" and that they represent surviving relicts of the old dogs of the Miocene and Pliocene ages of western North America.

During the long evolution of the family the shearing and crushing teeth became modified in different directions. In certain ancestral lines, such as the wolves (Fig. 4) and dholes, the length of the blade of the upper shear tooth usually exceeds the combined lengths of the first and second upper molars. In other lines, the shear tooth diminished while the molars became larger, as in the large-eared Cape dog, *Otocyon megalotis.* In the latter the molars have also increased secondarily in number, by budding of the dental germ during development, until there may be as many as four molars on each side in the upper and four in the lower jaw. In the South American Bush Dog (*Icticyon venaticus*), on the other hand, the number of upper molars on each side is reduced to one above and one below. In the lines leading to the bears the first and second upper molars grew longer, the second finally becoming enormous, while the shear tooth dwindled to small size and degenerate characteristics.

After this introduction we may pass to a selected but fairly representative list of the principal types of living Canidae, illustrated with photographs from the files of the New York Zoological Society. In compiling this list I have had the benefit of the advice of Mr. Harold E. Anthony, Curator of Mammals in the American Museum of Natural History.

Fig. 3. Head of fossil giant dog (*Dinocyon gidleyi* Matthew) from the Miocene of Texas. Restoration by Charles R. Knight, American Museum of Natural History.

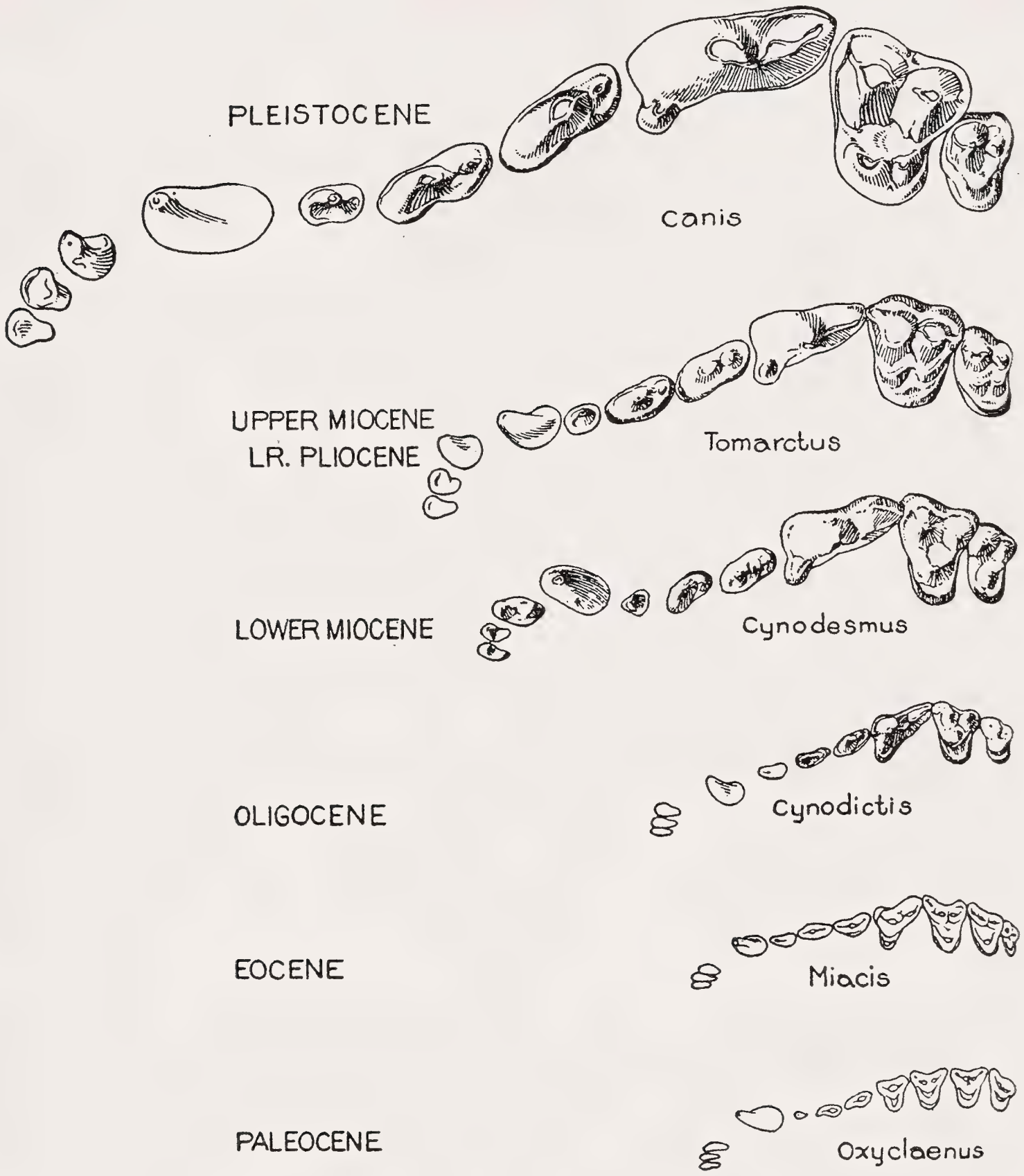


Fig. 4. Evolution of the upper teeth, leading to the true dogs. After W. D. Matthew.

LIST OF PRINCIPAL TYPES OF DOGS

Canis familiaris.

Canis dingo. The dingo of Australia.

Closely related to the true dogs and probably brought to Australia by the earliest Australian aborigines.

*Canis poutiatini.**

Azilian to Russian Neolithic.

*Canis palustris.**

Neolithic. Ancestor of Spitz, Samoyeds, Lapps, Terriers, etc.

Canis aureus, etc. Jackals.

Canis latrans. Coyote.

Canis lupus. Wolf.

Nyctereutes procyonoides. Raccoon Dog.

Vulpes vulpes (Linn.). Red Fox.

Vulpes velox. Kit Fox.

Vulpes corsac. The Corsac. Asiatic steppes.

Alopex lagopus (Linn.). Arctic Fox.

Brown in summer, white in winter. The Blue Fox is a variant.

Megalotis zerda Zimmermann. The Fennec.

Very large ears. African and Asiatic deserts and steppes.

Chrysocyon jubatus Hamilton Smith. "Maned Wolf."

South America. Very inappropriate name, according to Lydekker, as it is neither wolf nor

*Fossil.

definitely maned. Long legs, big ears, round pupils, flesh-tooth small and exceptionally short; m^1, m^2, exceptionally long in proportion. Solitary in habits. Skull recalls that of coyote.

Cerdocyon thous thous (= *Canis azarae* Wied). Crab-eating Dogs.

South America. Several species, including *cancrivorous*.

Pseudalopex magellanicus (= *Canis magellanicus* Gray). The Culpeo.

The Andes, Peru, Bolivia, etc. Wide range and many species.

Skull very coyote-like with low depressed forehead.

Lycalopex vetulus Lund. (= *Nothocyon* Wortman and Matthew; *Eunothocyon* Allen). Small-toothed Dogs.

South America. Very short face, very small carnassials, upper molars not wide transversely.

Dusicyon australis darwini Thomas.*

Darwin's Dogs of the Falklands, now extinct. May belong in lupine series near coyote.

"Canis" microtus. Small-eared Dog.

Lycaon pictus Temm. African Hunting Dog.

Allied with lupine series. Only four toes on each foot.

Lycaon anglicus.*

Pleistocene of Wales.

Cyon javanicus. Dholes.

Oriental region of Central Asia. Third lower molar wanting.

Regarded by Matthew as descendant of the Miocene *Temnocyon*.

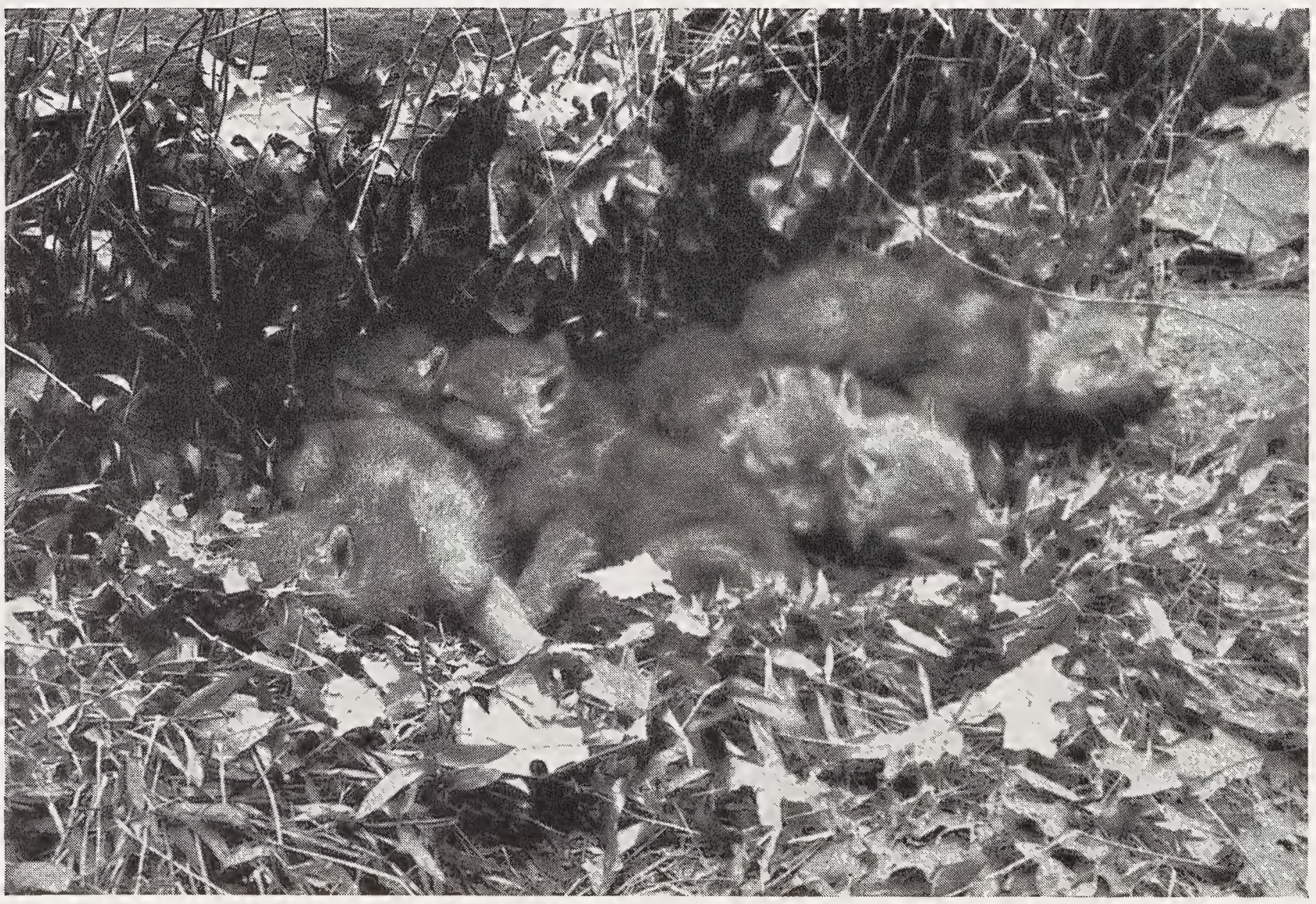
Icticyon (*Speothos*) *venaticus* Lund. Bush Dog.

Guiana and Brazil. Molars remarkably cat-like, reduced to $m\frac{1}{2}$. Short-legged. Also in Pleistocene of Brazil.

Otocyon megalotis.

Molars $m\frac{3 \text{ or } 4}{4}$. Total, 46 or 48 teeth.

Lower carnassials with 5 cusps. Skull like that of small fox. Limbs long, ears extremely large, auditory bullae very large.



Wolf pups born in the New York Zoological Park. The young of the gray or timber wolf are usually five in number. They are sooty-brown in color and are distinguishable from coyote puppies by the large size of the head.

Eskimo dogs. Very near to the wolf, but a faithful servant of Arctic explorers. One of these dogs was Bridge, Peary's lead dog on his last polar trip.

The dingo, dog of the Australian aboriginals. Has been in Australia since the days of its giant cave animals but may have been brought in by the proto-Australians, who probably came down from Southeastern Asia.

B'ack-backed jackal. *Canis mesomelas* of Africa. It is very much like the dark phase of the Azara Dog of South America and is the handsomest of the jackals.

Indian jackal, *Canis aureus,* the common jackal of Asia. He is light in color, with a bushy tail. In the large towns in India, jackals prowl about the streets and act as scavengers. The jackal will mix with domestic dogs, and the crossing of these animals with so called wolf-dogs is supposed to account for existing varieties of dogs. Aureus (Latin) means yellow.

The coyote, *Canis latrans*. A typical wild dog, descendant of a long line of fossil ancestors of North America. Albino phase. The specific name of this animal (*latrans*) means barking.

The coyote or prairie wolf is about one third smaller than the gray wolf, but in form and color the two look much alike. While the timber wolf is a dangerous animal to man, the coyote is the reverse. He is bold only in the persistence with which he clings to the outskirts of civilization.

Timber wolf, *Canis nubilis*. The type of this species is a strong, robust animal, cunning and merciless. It is shaggy and coarse haired. Called the timber wolf, it is equally at home on the treeless plains of the West, the evergreen forests of British Columbia and the barren grounds of Arctic America.

The Japanese and Chinese raccoon dog (*Nyctereutes procyonoides*). The distant resemblance to a raccoon is illusory, as this animal is true canid. It is said to hibernate like a badger.

Red fox, *Vulpes fulvus*. The famous cunning and intelligence of the fox must be of use to him in nature in outwitting the birds, rabbits, etc., upon which he feeds.

The gray fox is the fox of the South although it ranges northward well into the territory of the red fox. This species is distinctly smaller and more lightly built than the red, and the pelage is not so luxuriant.

The swift or kit fox, *Vulpes velox*. Some of the smaller Canidae, like the fennecs of Asia and Africa, even surpass the swift fox in the enormous size of their ears.

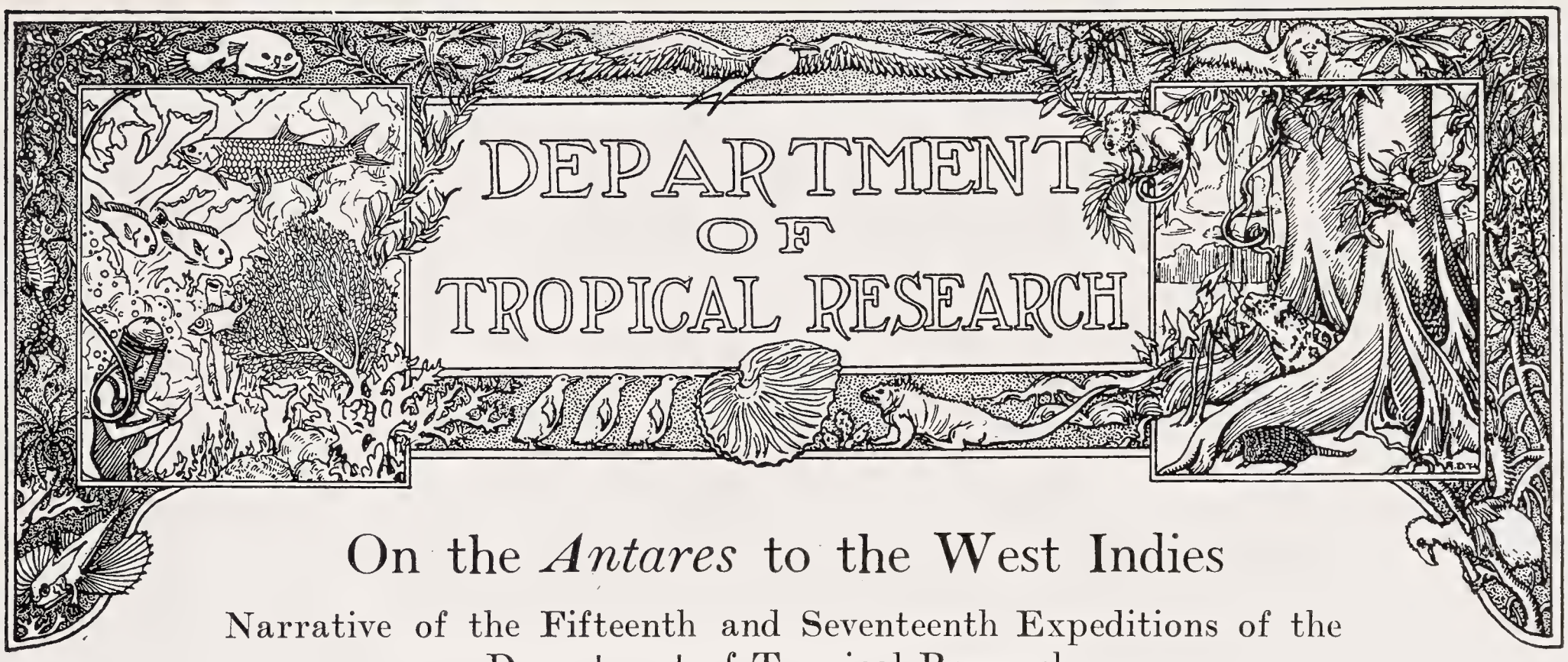
The Arctic fox, *Alopex lagopus*, in its white winter dress, affords a classic case of adjustment to the environment.

The crab-eating dog, *Cerdocyon* sp., of South America. The various species of South American canids exhibit a puzzling mixture of fox-like and dog-like characters. Some are probably nearer to the dogs.

The small-eared dog, *Canis microtus,* of South America. A very rare form.

The Cape hunting dog, *Lycaon pictus* of East and South Africa, is a blood-thirsty hyaena-like dog that hunts in packs.

The bush dog, *Icticyon,* of South America. One of the most curious of all living Canidae, distinguished by his short muzzle and by the loss of his second upper and lower molars, so that his dentition is almost cat-like. He may be remotely related to the Dholes (Cyon) of India.



On the *Antares* to the West Indies

Narrative of the Fifteenth and Seventeenth Expeditions of the Department of Tropical Research

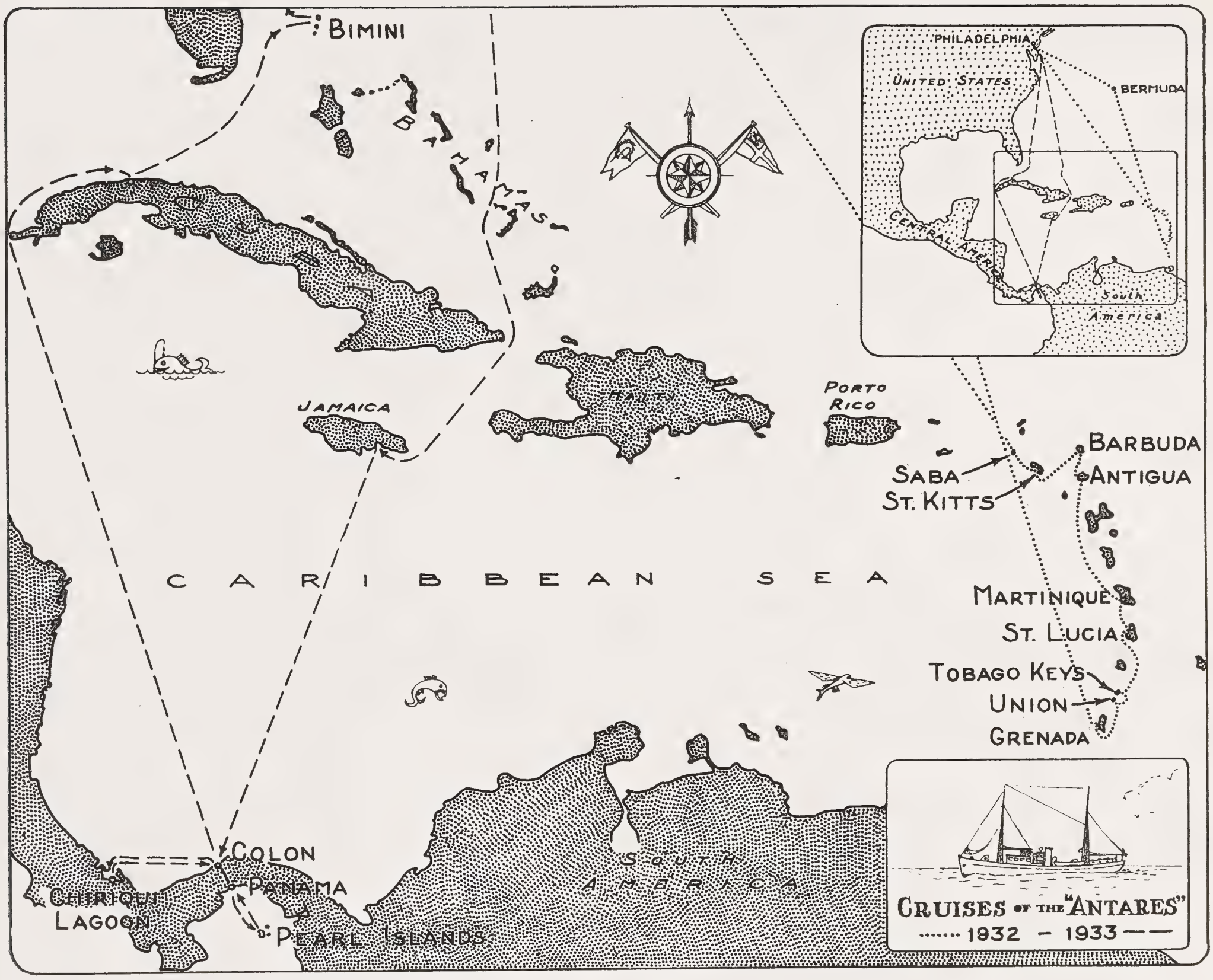
William Beebe

Illustrations from photographs made by Col. E. M. Chance, William Beebe and Gloria Hollister.

FOR the past two years members of the Zoological Society's Department of Tropical Research have been enabled to take short trips of exploration to little-known places in the West Indies, for the purpose of studying the fish life of those waters. This has been through the courtesy of Colonel Edwin M. Chance of Philadelphia on his diesel yacht—the *Antares*—which measures 105 by 22 feet, ably built, well-manned, with every inch of space put to ingenious use, so that we have been as comfortable as on a ship of much larger size.

The *Antares* at sea. From a photograph by E. M. Chance.

In 1931 Colonel and Mrs. Chance came to Bermuda on the *Antares* and spent some time with us on Nonsuch, and in 1932 Miss Hollister and I were invited to meet them at the Corinth-



Route of the 1932 and 1933 Cruises of the *Antares* from Philadelphia to the West Indies and Panama. From a drawing by John Tee-Van.

ian Yacht Club in Philadelphia and start thence on a West Indies trip, with abundant opportunity to increase our knowledge of fish.

We could have gone to Porto Rico or Cuba, to Haiti or to Trinidad, but any tourist vessel would have taken us there, and instead, we chose little-known islands, such as Union, Tobago Keys, Barbuda and Saba.

One of the most amazing things about these trips is their slight cost. We found that, given a boat of this size, one may sail away over tropical seas, with a maximum comfort, covering from 4000 to 5000 miles, and, with fuel oil at ten cents a mile, crew's wages, harbor dues, food,—all expenses for five weeks will amount to less than $1500.

Our first venture was the Grenadines. We sailed down the length of the Leeward Islands, each distinct and with a special beauty of its own, and then, beyond St. Lucia, these larger islands suddenly spatter out into a long line of tiny dots and dashes, getting smaller and smaller, until the chain ends abruptly in the solid mountain ranges of Grenada. All tourist vessels hurry past these and carry their cargo of impatient minds to the next port where some city offers alien similarities of sorts to their home towns.

The names of these little Grenadines reach back to the days of Caribs and pirates—Bequia, Mistique, Marquis, Kickem-Jenny, Carriacou, Frigate, Les Taintes, Mayero, Batovia, Adam, Union, and Isle de Caille.

We steamed straight for Grenada where we were watered, laundered, provisioned and armed with permits to land anywhere on the tiny islets

to the north. Our first Grenadine stop was Union, and except for the call of time and duty and home ties we would be there yet, for few lovelier places exist. A deep, incurved bay rose up and up to a majestic, thousand-foot range, with flowers and strong, spicy scents and the voices of strange birds delighting our senses. Later we made the acquaintance of the inhabitants—gentle, courteous, colored folk to whom the visit of a yacht was rarer than an eclipse.

On the first day of our search we found a coral-filled lagoon behind an islet draped with

Exploring Tobago Keys in the Grenadines. This group of Islands was the first stop in the 1932 cruise of the *Antares*.

night-blooming cereus. Here we dived and fished and in less than three days captured or recorded one hundred and ten species of fish. Our work was not made easy by the presence of tidepools for there was only a scant eighteen inches of tide. Many of the parrotfish and wrasse were old Haiti and Bermuda friends, but such things as scarlet-backed demoiselles and a flock of a dozen young devilfish were sights strange to us. Again and again a quartet of big tarpon, at least six feet in length, would swim close to us when we were walking about, two to three fathoms down, and yet no bait or lure ever tempted them. Beautiful blue and yellow demoiselle fishlets were everywhere, together with flaming angelfish and smug little blennies.

From early dawn to dusk the air and water of the bay teemed with life—pelicans, gulls, ospreys and frigate-birds, dolphins, bonitos and great leaping tunnies. After the raucous beggars and shrieking automobile horns of Grenada we called this the Subdued Island, and learned to love it.

Our next stop was at Martinique—an old friend in a new dress—the morning of Bastille Day, forty-eight hours of continuous fête of color, noise and absinthe as only French Colonials can combine them. From the frantic heart of Fort-de-France we motored through many miles of wonderful tree-ferns to the quiet majesty of Pelee. A place of colorful interest and source of desirable specimens was the fish market of St. Pierre—a pitiful village still in the weird process of digging itself out of the lava and ashes.

We had a thousand laughs at the happenings of those two joyous days, but on the last day the natives had their turn, when we caught sight of a sturdy fisherman staggering along under the weight of an enormous fish—a rare tuna over six feet in length. To the amusement of the Martinicans we pursued the fisherman at full speed and persuaded him to stand and slowly revolve in the middle of the street as we made notes on measurements and colors.

At Antigua we stopped long enough to collect

The Island of Martinique. The peak in the background is Mount Pelee, with its last lava flow stretching down to the sea.

The great chain of the Leeward Islands is all connected visually. This view is from a mountain fortification on St. Kitts northward to St. Eustatius, beyond which is Saba.

in the tidepools of Deep Bay, and to swim over the old wreck which has been here for thirty years. Fifteen years ago when en route to Kartabo in British Guiana we used to land here, and today as then, the ancient, sunken hold was filled with snappers, groupers, tarpon and angelfish, swimming in and out of the skeleton cabins.

We used Antigua as a stepping-off place for the strange, isolated island of Barbuda, thirty miles to the northeast. Barbuda is the terror of navigators, and a gruesome map shows a double or triple line of dots all around its shores, each dot representing a vessel—from coastwise schooner to battleship—which failed to detect the low lying shores and piled up, a complete wreck, on the sand or jagged reefs.

A lonely Martello Tower, built centuries ago by unknown hands, is the only landing mark. We shot through the surf and slithered up a beach of untold myriads of tiny shells, which tinkled in the breeze and, in the sun, glowed with a warm pink lustre. We found this one of the strangest of all islands, filled with hints of the original ideas of past British owners—the Codrington family. They loved sport and so they stocked their new home with guineafowl, wild boars and fallow deer, and today we heard or saw all three. To keep these creatures from destroying their gardens, the natives have had to build wattled fences and now we come upon groups of conical huts and wattled kraals and compounds which might well have been built in the heart of Africa. Most interesting of all were the natives themselves, magnificent negroes, six feet three and four, with the shoulders and muscles of heavy-weight fighters, but gentle of voice and courteous of manner. They are the results of the breeding for superslaves which the Codringtons carried on for generations, bringing the finest types of black men and women to the island and breeding them for size, bone, and sinew. I can imagine no better place to study human genetics.

Here we had to fight for a glimpse of the coral reef fish. The breakers pounded in and swept us off our feet, and only by quick dashes forward with the water-glass could we see the great green parrots grazing on the coral branches, and the bright colored wrasse and surgeons swept back and forth by the swell of the open sea.

Our last port of call had nothing to do with fish. It was Saba, the tiny volcanic peak which thrusts up from mid-water between St. Croix and St. Eustatius and is pointed out to every passenger to the West Indies. For no reason at all, we must pronounce it Sayba, not Sahba. To all tourists it is as inaccessible as the sea bottom over which they are passing. For no steamers touch there, and the single volcanic peak rising abruptly from the waves offers no harbor, wharf, beach, or anchorage. We go ashore in a dory, slithering up through the surf to a temporary hold on large black pebbles, and then rush the boat up out of the way of the next roller.

Pleasant half-Dutch boys greet us, and we wait for the customs officer, who finally comes riding down the eight hundred steps on a pony. We climb and climb, view after view opening and closing behind us, until at last we turn a mighty spur and find ourselves on the bottom of the island crater, with the tiny capital spread out before us—the village of Bottom.

It is like nothing else in the world; its charm is wholly its own; narrow high-walled lanes or streets (there is not a wheel or a cart in the island), red and white houses, spic and span as if from a Christmas morning's toy village; shy women offering delicate lacework for "anything you like to give"; the pleasant Episcopal rector, eager for real conversation, whose diminutive house shelters a marvelous collection of brasses, three brown doves, a black cat, and a green parrot. The adjoining church, which had once been a barn, and the cemetery might be translated direct from a typical English village.

I sit in the cool dim light and read the memorials on the walls. Each tells its own story of the perils of life of these people. Here is one, revealing the toll of life taken by a single storm:—

IN LOVING MEMORY OF

JOHN SIMMONS, AGE 52 YEARS
DAVID SIMMONS, AGE 40 YEARS
RICHARD R. SIMMONS, AGE 22 YEARS
ISSAC SIMMONS, AGE 16 YEARS

LOST AT SEA, SEPTEMBER, 1918

WE CANNOT, LORD, THY PURPOSE SEE,
BUT ALL IS WELL THAT'S DONE BY THEE.

The Governor and his charming wife change our status within a few minutes from visiting strangers to friends. They love the island and apparently their only regret is that high lobs on their tennis court are inadvisable, since the ball might go down a quarter mile into the sea. Even in our three hours' visit we destroy many silly myths which have grown up around this fairy isle of five square miles, but we find that the men actually do build most excellent boats, up to eighteen feet, in the lofty crater, in Bottom, boats which are subsequently carried down

Island of Barbuda. The lonely Martello Tower built centuries ago by unknown hands is the sole landing mark.

the hundreds of steps on the shoulders of a score of sturdy natives.

We steamed regretfully away and as the afternoon sun lighted up the greens and grays and illuminated the mists swirling about the uttermost summit, a great Pan-American plane came into view and steered her course directly over the crater of Saba.

On all these trips flying-fish came on board almost every night, and as a matter of course we described and preserved them. Accurate descriptions of the delicate wing pattern and pigmentation is not easy, yet it is necessary to record this at once, because when the wings have hardened in formaline it is impossible to spread them open again without injury. A method occurred to me, quite new as far as I was concerned, of cutting off the pectoral and pelvic fins of the left side, spreading and pinning them on white paper. They dried and adhered, and were described, labelled and filed away as easily as pressed flowers.

One night, about two hundred miles north of Sombrero, a three-inch flying-fish came aboard, which possessed a black, fleshy barbel as long as itself. I named this in honor of the *Antares*.

In the case of one fish the patterns of the two pectorals were quite unlike, so much so that they might almost have belonged to two different species. The left wings had much less black pigment than those of the opposite side and it seemed more than coincidence that also on the left side a large parasitic crustacean had taken hold. This was, in general appearance, like a large, black arrow which had been shot into the side of the fish, the head being buried, but the long shaft and a strongly feathered butt in full view. It was inserted close to one of the left wing fins and may in some way account for the small amount of black pigment on that side.

In opportunity for scientific work our 1933 trip on the *Antares* equalled that of the year before, while as to the places visited and our adventures nothing could be more different.

On June fourteenth of the present year we dropped down the Delaware River and on out to the open sea. The southward trip is always the same and always different; from bitter fogs we pass to velvet winds and sunshine; from chilled steel waters to those of turquoise and ultramarine; factory chimneys are exchanged for slender palms; mazes of shapeless clouds give way to the stately galleon ghosts of trade-winds; clots of eel-grass and floating flotsam are replaced by golden sargassum, while stormy petrels and herring gulls drift behind and vanish, their places taken by unbelievably graceful tropic- and frigatebirds and harlequin-plumaged sooty terns.

On the afternoon of June eighteenth we swung around Watling's Island, and on the twentieth anchored off Kingston, Jamaica. I had always avoided this island in my trips to the West Indies on account of its over-abundance of population, but I had never realized its supreme beauty of mountain trails and dashing torrents. We motored clear across the Blue Mountains and back. In memory I need only three things to reconstruct the island—a colored man, a banana tree and a cocoanut palm. Two government officials have begun a study of the long neglected fishes of Jamaica.

With our wake stained by the splendour of a tropical sunset, our diesels going full speed and sails filled with the augmented trades, we flew southward, while giant, clear-winged flying-fish rose before us or skimmed on board. Early on Sunday, the twenty-fifth, we passed the Colon lighthouse, and broke the trans-American record from sea to sea by going through the Panama Canal in five hours.

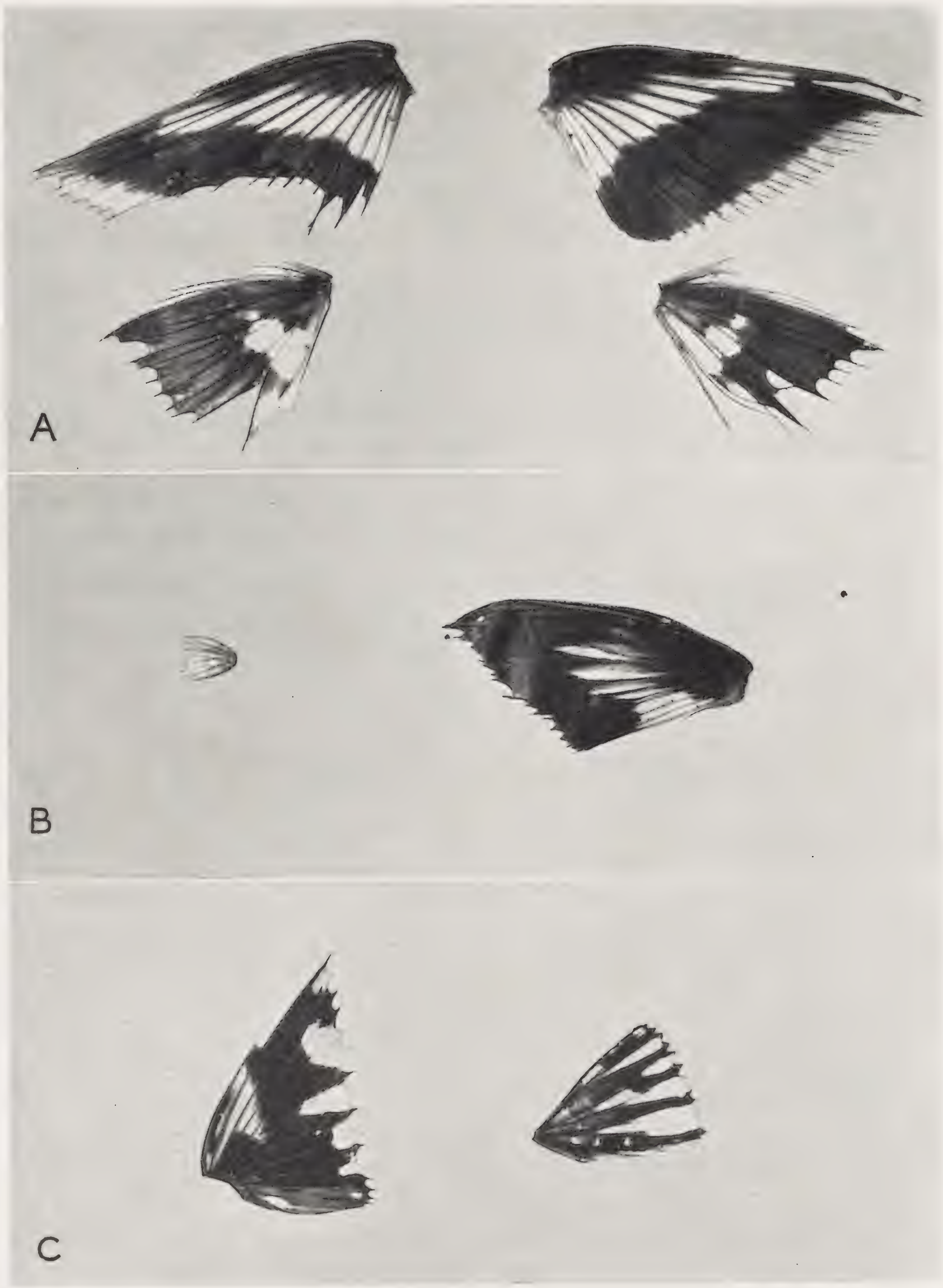
A village in Barbuda. Groups of conical thatched huts, encompassed by wattled fences, that are strangely similar to a native kraal in the heart of Africa.

Looking north from the breakwater I saw the edge of the jungle where, ten years before, I had spent a long, rainy night searching for yapocks or water opossums (Zoological Society Bulletin, Vol. XXVI, No. 6, pp. 150-156). It was on this occasion too, that I shot a five-foot bushmaster. What Dr. Ditmars has recorded of the rarity of this serpent in the Panama area of the isthmus seems to hold good for the Colon side, for this was the first bushmaster my guide had seen for eight years. (*Continued on page* 110)

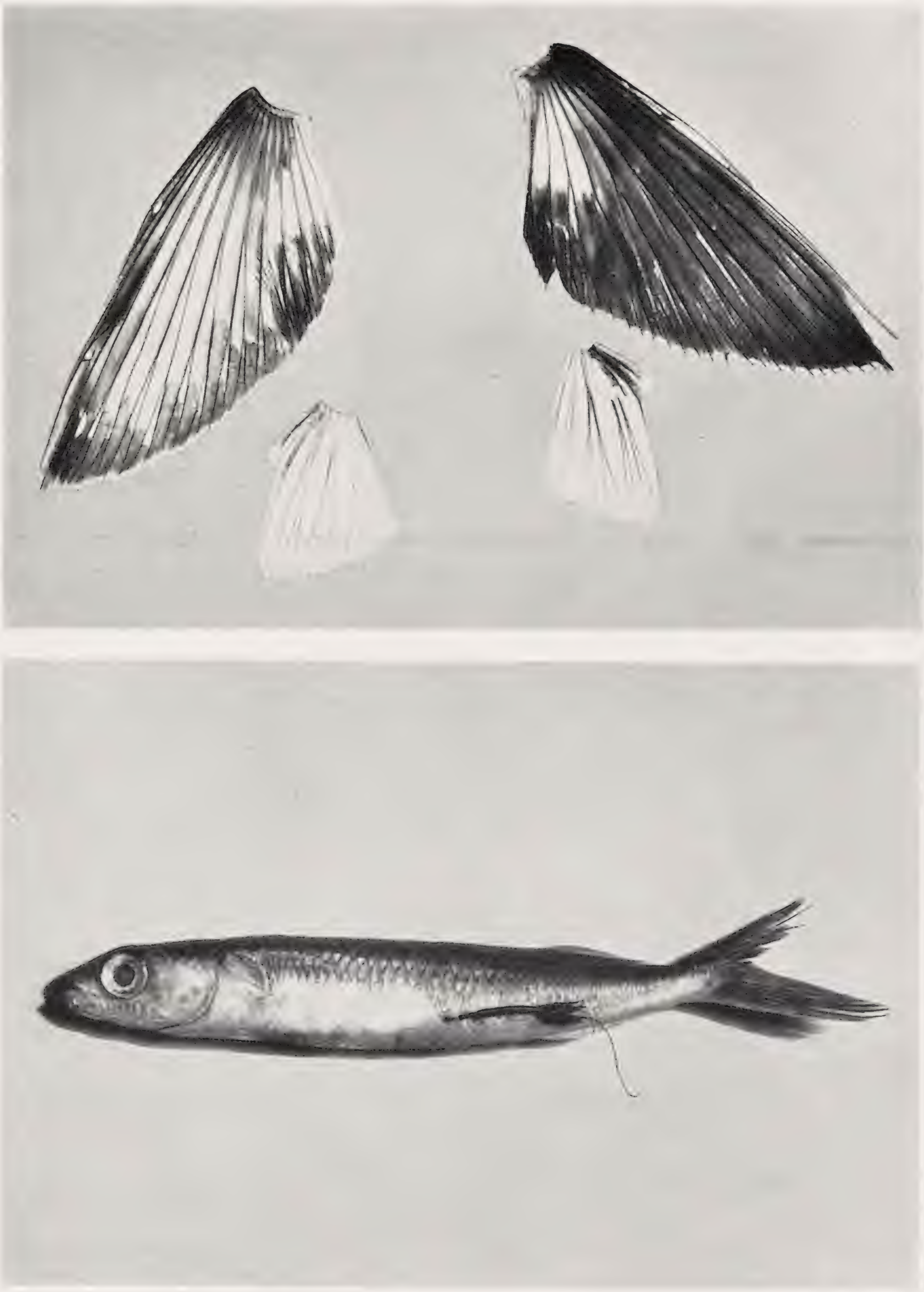
Saba, a tiny volcanic peak rising from the sea between St. Croix and St. Eustatius. As there is neither harbor nor anchorage, it is totally inaccessible to tourists. The upper picture shows the little village of Bottom, lying in the bottom of the extinct crater, and reached by a flight of 800 steps.

Oysters are in season. An old desert island myth comes to life as a reality. Bunches of oysters clinging to a mangrove branch, exposed by the ebbing tide. Chiriqui Lagoon.

The spider lily. This is one of the commonest flowers of the tropical jungle. Chiriqui Lagoon.



A. Short-barbelled Flyingfish *Cypselurus furcatus* (Mitchill). This is a common flyingfish. Our specimens show great variation in the wing pattern.
B. Two-winged Flyingfish *Halocypselus obtusirostris* (Günther). Note the very small pelvic fins quite useless for flight. The pectoral wings are very large, three-fourths as long as the whole fish. The pattern on the wings of this individual is quite unlike any published record.
C. Black Butterfly Flyingfish *Cypselurus* sp? This is probably an immature flyingfish of some undescribed species. The body was banded with brilliant golden-bronze and silvery.



Reddish-winged Flyingfish *Exonautes rubescens* (Rafinesque). The fore and hind wings are very unlike in color in this species. Notice the variation in the left and right pectorals of this individual, due perhaps to the presence of a large parasite crustacean. Lower. Reddish-winged Flyingfish *Exonautes rubescens* (Rafinesque). This fish is seven inches long. The wing fins have been cut off and are shown. Upper. Growing from the side is a parasitic crustacean, not yet identified, looking exactly like the shaft and butt of an arrow.

Dolphins swimming under the bow of the *Antares*. Two may be seen at some depth and a third, as indicated by the foamy area, is breaching.

Four dolphins crossing the bow of the *Antares*. These graceful swimmers maintain their pace with a precision almost mechanical.

In Balboa and Panama I renewed old acquaintances and motored both north and south through the jungle, stopping once to help a two-toed sloth in his painful passage across the smooth surface of the road. It was the rainy season and the worst time of the year for land creatures—birds were molting, animals shedding, butterflies bedraggled, flowers gone and fruit still to ripen. I realized, as I had so often in British Guiana, how strongly marked are tropical springs and autumns, in spite of sempiternal foliage and uninterrupted warmth. But anywhere, under any conditions, there is no place in the world so wonderful as the jungles of tropical America, and to sniff the pungent odors, hear the weird cries of birds and frogs, and again watch the great blue morphos and the slow heliconia butterflies after eight years of watery submergence,—all this was like the sheer renewal of some past incarnation.

One memorable visit was to Mrs. Bryan's aviaries, a tangled hodge-podge of cages rambling in all directions about her house, but with an amazing collection of birds of many groups in splendid condition. Mrs. Bryan is one of those natural born bird lovers of whom birds have no fear, and for whom they will breed at any time. Here were tinamous dropping their turquoise eggs about and hatching them out at the slightest encouragement; young, recently fledged motmots, Galapagos doves and callistes nesting in any place they could find. If this wonderful aviculturist had sufficient space and facilities there is hardly any species of bird which she could not raise.

On June twenty-sixth we weighed anchor and started westward across the waters of the Bay of Panama. This was my ninth trip, but this time we did not continue to the Galapagos but anchored close to Saboga, one of the most northern of the Pearl Islands.

A devilfish swimming a short distance below the surface. There are two great remoras or suckingfish attached to its wings. One may be seen quite distinctly against the black wing at the left.

In past years powerful Caciques have ruled their Indian tribes on these islands, and the name was warranted by the abundance and size of the pearls taken by divers, but now they are fallen from their high estate and support a meagre, miserable population who grow a few bananas and vegetables, but have no ambition even to fish for a living.

As the crow, or more appropriately, the cormorant flies, we were only a half hundred miles from the Atlantic coast, but there was no doubt

of this being a different ocean. Instead of one or two feet of tide, here we found eighteen feet and in consequence tidepools were available, the inmates of which we proceeded to poison with unsportsmanlike joy. Even on the first day I was impressed with the remarkable resemblance to the fishes of the Galapagos compared with the forms recorded from Panama and this was confirmed again and again. We collected species after species which I had taken from Tower and Indefatigable Island five hundred miles to the west, which appear to be absent from the Panama coast, within sight, forty miles east.

day, as it swam, or rather flew, slowly back and forth between two islands. It was not a large one, only about six feet across the wings, but to it were attached two relatively enormous remoras or sucking fish. These were at least two and one-half feet in length, and were adhering to the upper side of the wings near the body — the shoulders we might say. In this position, fastened as they were by the disk on top of their heads, they were upside down, and whenever the manta came near the surface of the water their gaping gills would protrude. Yet they never shifted their position.

The devilfish rising and swimming near the surface. The gills of the remora may be seen protruding at the right of the picture, just forward of the black triangular wing-tip of the devilfish.

The tiny islets scattered about proved to be much more interesting than the larger of the Pearl group and on our various trips to and from those we found that the water and air hereabouts abounded in life.

The excellence of the fishing drew launchfuls of young army officers from Balboa, and every few days a plane would circle down, bringing several navy men to try for a sailfish. But far more skilful fishers were present in thousands—cormorants, pelicans, boobies and frigate-birds, each with its particular methods.

We followed a manta or devilfish about, one

Wherever we fished or set off dynamite caps we found interesting fish. With our eyes fresh from those of Bermuda we found strange replacements. Instead of blue-headed wrasse we caught one with a head of royal purple, a greenish yellow band at the neck, and the rest of the body clear magenta (*Thalassoma duperrey*).

Our big-game fishermen caught bonitas, barracuda and dolphin until they were weary, but showed anything but ennui when they came back with a giant sailfish and a wahoo.

Dramatic occurrences came and passed with incredible speed. One day when trolling stead-

Spotted anglerfish, *Antennarius scaber* awaiting his prey. Directly above the nose of the angler is the lure, a perfect imitation of a wriggling gray worm, attached to a short, flexible jointed tentacle.

The anglerfish attracting its prey by violently moving the worm-like lure. When the object has moved into the direct sphere of possibility, the great mouth of the angler opens, and in the current created, the minnow is engulfed so quickly that it deceives the eye.

The anglerfish with all fins spread. All the photographs of the anglerfish were made by L. C. Dunton at the New York Aquarium.

Immense schools of anchovies in the Pearl Islands are attacked by dolphin fish and mackerel from beneath, and by hosts of brown boobies and cormorants from above. The boobies are in turn robbed of their prey by frigate-birds which wait for them high in the air. From a drawing by Helen Tee-Van.

ily ahead over a quiet sea, without warning the waters suddenly were troubled as in a tide rip. Through the clear depths we saw thousands of tragedies going on, mackerel and bonitos pursuing hosts of anchovies. Then, from nowhere five or six hundred boobies materialized, dropping out of the sky on all sides, head first into the water like a flight of arrows. As they rose, heavy weighted with their prey, gaunt frigate-birds appeared, and nonchalantly but inexorably bore them down and seized the hard-earned fish.

So for a week we gleaned our harvest of specimens and notes from the Perlas, then back and through the Canal, and north to Chiriqui Lagoon, the wildest place we had yet seen. This Mosquito Coast is saddled with one of the worst reputations in the world. Even the sane "Coast Pilot" tells of the constant dangers from sharks and sting rays and reports the adjacent jungle as being infested with poisonous snakes. Yet during the week we were there we saw only two sharks, each of which desired earnestly to escape, and in many miles of walking and cutting through the jungle we saw but a single, small coral snake, so young that it was quite innocuous and could be picked up with impunity.

We took many rare fish around our submarine light and one evening, after capturing a young flying gurnard, five of us verified the aerial ability of these armored fish, watching them rush at the light, emerge and glide along at least five feet above the surface.

We made friends with the Valiente Indians, their smiles enhanced by their filed teeth, and we collected the ever interesting heliconid butterflies and their amazing mimics; we listened to the

weird chorus of the big, black, howling monkeys, and after a week of steady study of the fish, we started northward for Havana.

Our homeward voyage was anything but peaceful, for we had to dodge four July hurricanes, one of which drove us back to Colon for shelter. But no day at sea was wasted, and we caught sargassum weed and the fish therein, and took the flyingfish manna which came in darkness, and watched and saw again the strange unnamed flying squids (Zoological Society Bulletin, Vol. XXXV, No. 5, pp. 177-178).

On mirror-like days we took photographs of dolphins playing under our bow, and in Havana with the revolution casting its shadow a week ahead, we secured one of the most interesting of the Angler fishes, *Antennarius scaber,* and brought it back alive to our New York aquarium.

Its lure was, in size, shape, color and movement, a perfect imitation of a wriggling, grayish-white worm. While still on board the *Antares* it devoured three of its own cousins, and a beautiful blue-starred demoiselle. Twice I watched the process, and both times while the prospective prey was at least two inches away, the frogfish opened its mouth and with no apparent effort, created such a maelstrom, such an irresistible current, that the human eye could not see the fish disappear. It simply vanished from sight, the lure was tucked away and we imagined a gleam of satisfaction in the fishy eye.

In the aquarium, *Antennarius* was housed with a herd of sea horses, but their armor proved no protection and three were forthwith devoured. Truly this is a worthy daylight, surface cousin of the great deep-sea-devils which I bring up in my nets with glowing blue and white flares for lures.

On July thirtieth we tied up at the Corinthian Yacht Club in Philadelphia, and the New York Zoological Society's Seventeenth Expedition came to an end.

MIGRATION OF FISHES

Introduction by WILLIAM BEEBE

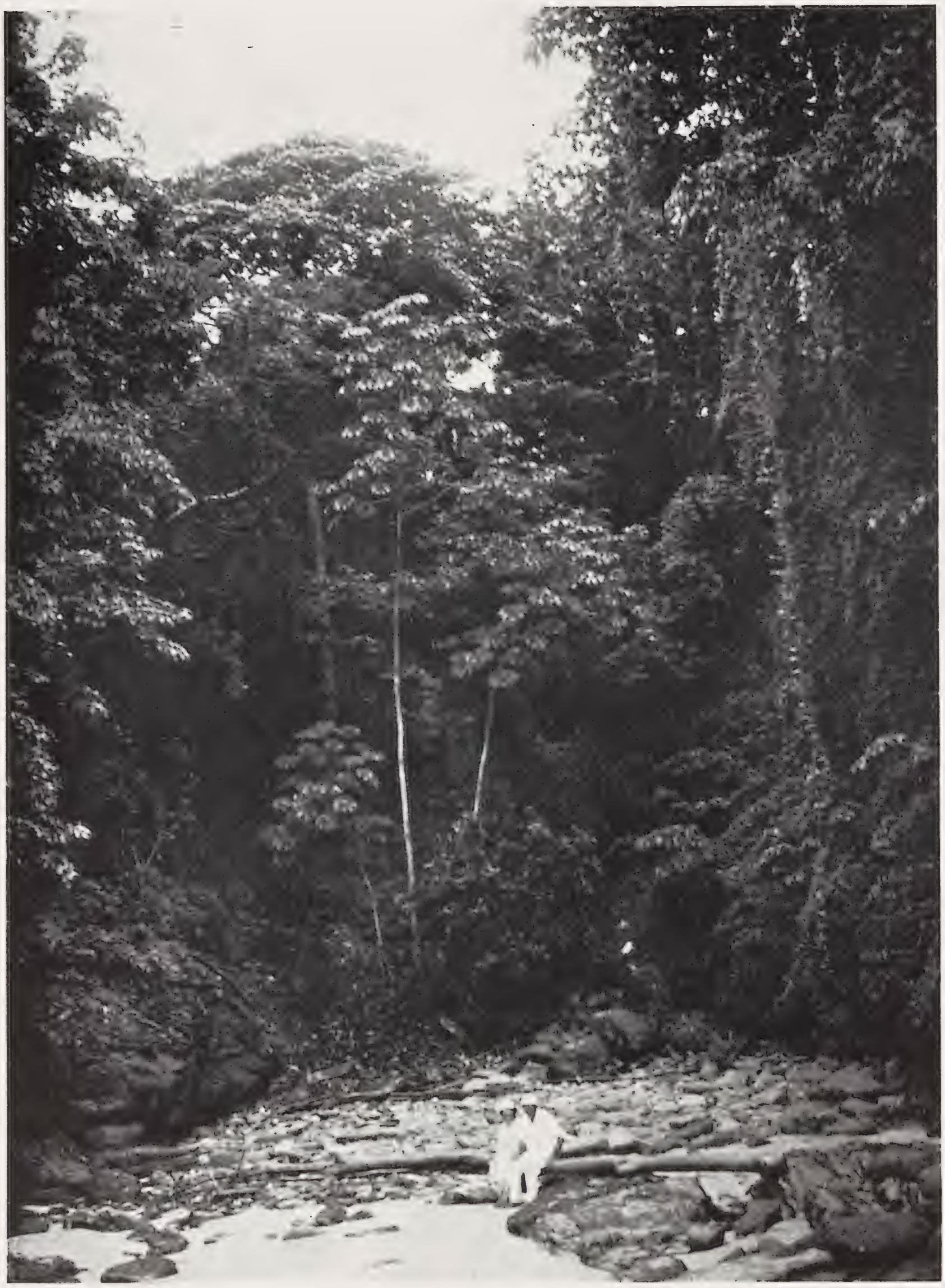
THIS volume is concerned with the Travels and Migrations of Fish, and the very able author, Dr. Louis Roule, has condensed into the space of nineteen chapters the sum of present day knowledge of these subjects. But best of all, he has put this into understandable language and has brought out all the mystery, the drama, the amazing actions, many of them still unexplained, which accompany this phase of the lives of fish. What is known of this fascinating aspect of life in the waters of the earth has hitherto been locked up in technical books. So here we find a double translation—first from the dry recitation of facts into a moving, living account, and secondly from the original French into most excellent English.

The translator has wisely kept as much as possible to the clear style and the pleasant individuality of writing of the author, and has made use of an amazingly extensive English vocabulary to cope adequately with the delicate shades of meaning for which the French language is deservedly famed.

This is one of a series of popular volumes which the author has published for the French reading public, and their welcome has been most cordial. Dr. Roule is a well-known scientific student of fish, with many authoritative researches to his credit, so he brings to this popular work a sound background of knowledge, leavened with an emotional appreciation of its wide appeal.

The subject of the Migration of Fish is here given the play of imagination in the recording of actual facts which it deserves, and the layman will find an astonishing field of interest in an aspect of life which is as dramatic and absorbing as it is new to the scope of popular literature.

*Fishes: Their Journeys and Migrations". By Louis Roule 270 pp., 54 text ills. Published by W. W. Norton and Co., New York, N. Y.



The tropical forest of Pacheca in the Pearl Islands. The jungle grows down to the water's edge. It is a labyrinth of vines and lush foliage that forms a barrier that nearly defies penetration.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

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Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-five volumes completed. Volume XXXVI in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

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Field Book of Shore Fishes of Bermuda (Beebe-Tee-Van); 337 pp. 343 ills.
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The Arcturus Adventure (Beebe); 449 pp. 77 ills.
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Sea Shore Life (Mayer). *Out of print.*
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Post-cards: General Exhibits. Sets (12) colored.
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For all Aquarium publications or any work relating to Aquatic Life, address the NEW YORK AQUARIUM, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. MITCHELL, *Mgr., Zoological Park, 185th St. and Southern Boulevard, New York City.*

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Vol. XXXVI, No. 5

Contents

September-October, 1933

REPRESENTATIVES OF FOUR FAMILIES OF CARNIVORES.....*Frontispiece*

THE SMALLER CARNIVORES .....*Raymond L. Ditmars* 119

Illustrations

Indian Civet
African Civet
Binturong
Meerkat
Suricate
Fisher
Black-footed Ferret
Eastern Weasel
American Black Footed Ferret
American Mink
Wolverine
Common Skunk
Honey Badger
American Badger
Canadian Otter
Crab-eating Raccoon
Eastern Raccoon
Ring-tailed "Cat"
Coati Mundi
Ring-tailed Coati
Kinkajou
Panda

PANDA ..... *Cover*

BULLETIN

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DEC 27 1933

THE SMALLER CARNIVORES

Representatives of four families. 1. American black-footed ferret, *Putorius nigripes. Mustelidae;* 2. American badger, *Taxidea taxus. Mustelidae;* 3. African civet, *Civettictis civetta. Viverridae;* 4. Coati mundi, *Nasua narica. Procyonidae;* 5. Raccoon, *Procyon lotor. Procyonidae;* 6. Himalayan Panda, *Ailurus fulgens. Ailuridae.*

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The Smaller Carnivores

RAYMOND L. DITMARS

Curator of Mammals and Reptiles, New York Zoological Park.

All of the illustrations accompanying this article were made from photographs taken in the Zoological Park.

WHILE some of the world's most spectacular types of animals are members of the Carnivora, the larger species of this extensive order form a scant minority. Such carnivores as the lion, tiger, leopard, cheetah, ounce, jaguar and puma greatly dominate the feline family in size, and some Alaskan bears attain a weight of over twelve hundred pounds, but the great array of carnivorous animals remains, these of moderate or small size, ranging down to the diminutive weasels.

There is considerable variety in form among carnivores, but phases of adaptation are not so marked as with members of some other orders. The greater number are terrestrial; some are semi-aquatic and show fair specialization. A number are arboreal, but in following such habits have not acquired the marked structural characteristics of mammals of other groups.

Carnivores are widely distributed, from within the Arctic circle through the tropical latitudes. They are lacking in Australia and New Zealand, with the exception of the dingo, in the former; and actually, the status of Australia's wild dog is clouded by the thought of it having been introduced by pioneering human races.

In the common definition of the Carnivora as the "flesh-eating animals," a weak title has been established. True enough, the greater number are flesh-eating, but a fair portion vary such diet with fruits and herbs. Then again, there are many mammals of unrelated orders which are flesh-eaters. However, there is no grouping of mammals so generally carnivorous as that figuring in the present article.

There are eleven distinct families making up the Carnivora, and of these the collections of the New York Zoological Society have contained representatives of eight. While the Lion House is limited to exhibition of species of the *Felidae,* and the Bear Dens, also the Wolf and Fox Dens, have represented two additional families, the greater number of our species of carnivores are exhibited in the Small Mammal House. Here the majority have been members of two families, the *Viverridae* and the *Mustelidae,* and the accompanying illustrations largely relate to members of these families. The tendency, with both groupings, is toward elongate and rather sinuous bodies, with short limbs. The *Viverridae,* containing the civets, genets, mongooses and palm "cats," is strictly an Old World family. Members of the *Mustelidae* occur both in the Old and New World and among them are the weasels, badgers, otters, martens, sable, mink, skunks and wolverine, the latter indicating the largest size these animals attain.

Some scientific writers are inclined to the belief that there should be a considerable separation in classification between the *Viverridae* and *Mustelidae;* that the latter show skull characters indicating relationship with the bears and raccoons. The similarity of forms among both families is hence accounted for as parallel development, without relationship. Other students, however, contend that evidence furnished by

Indian civet, *Viverra zibetha*. This species attains a length of approximately fifty inches, of which eighteen are occupied by the tail. It lives in thick, brushy areas and is nocturnal.

forms of extinct carnivores point to the viverrines representing the ancestral stock whence the mustelines were derived. The illustrations with this article are grouped to afford a comparison of the species of both families.

The most interesting viverrine we have exhibited has been one of the smallest—the Indian mongoose. This animal is really a necessary part of a collection of living animals, owing to its fame as the enemy of the deadly cobra. It is not, as has been alleged, immune to the poison of the cobra, but depends upon its agility in dodging the serpent's rather slow and sweeping stroke and darting in to fasten its teeth in the reptile's neck, thus severing the spinal cord. It is difficult to obtain a mongoose for exhibition. While the species is common enough, the United States government has imposed laws against its importation, owing to the possibility of it escaping, breeding, and becoming a menace to poultry and wild birds, a condition sadly demonstrated in the West Indies where the mongoose was introduced and has become a formidable pest.

The common mongoose of India represents a considerable group of very similar animals, all of which savagely prey upon reptiles, small mammals and birds. A dozen species of the mongoose genus extend over southerly Asia, much of Malaysia, and Africa; in the latter country is a species three times the size of the Indian mongoose. The immediately allied suricate and meerkat, of Africa, have also been exhibited in the Park. The government ban relates to the exclusion of all of them. Similar laws are in effect in the tropical American countries.

The genets are larger than members of the mongoose group, several kinds inhabiting Africa and one extending into southerly Europe. The form is cat-like, but much elongated, while the limbs are short. In slinking gait, with bodies pressed to the ground, these animals are singularly serpentine in aspect, the impression being heightened by the vividly blotched body, the prevailing pattern among genets being large, dark spots upon a body hue of brown or yellow. Genets, like members of the mongoose clan, are readily tamed as pets, but remain ferociously combative among small mammals. Hence, like other small viverrines, they are often kept in houses for the purpose of killing rats and mice—although their depredations may extend to the destruction of innocuous, rodent - destroying snakes and luckless birds succumbing to sinuous stalking and agile rush.

The palm civets form a connecting link between the slender-bodied viverrines and the rather stout-bodied civets, of which two species stand rather prominently. One of these is the Indian civet, with a total length from snout to tip of tail of about fifty inches. It is of rather cat-like form, gray, with blackish rings. The African civet is of similar length, but of stouter form and more heavily haired. The pattern consists of a mixture of bands and blotches. It is illustrated among the accompanying photographs. These animals have assumed prominence owing to a secretion in glands near the base of the tail, used in the production of some types of perfumes to retard the volatile action of the respective scents. As a base to such perfumes, the secretion of the civets renders the odors, even in small quantities of the perfume used, extremely persistent. The secretion of these glands is sometimes disagreeably apparent when a series of living civets is exhibited. A heavy and sweetish odor may be associated with the animals, and this is particularly accentuated when the air contains a high percentage of humidity.

The largest of the viverrines is the binturong, also called the bear-cat. It is arboreal and by some authors is designated as a big tree civet. Its distribution embraces India, the Malay Peninsula, Sumatra and Java. Its tail is long and bushy, and the total length from snout to tip of tail of a large example is approximately five feet. To the writer, its domination in size over the other viverrines, is analogous to that of the wolverine among the musteline types.

Among our exhibits of mustelines, there has been a series of species closely matching in size the collection of viverrines. We have found, however, that the smaller mustelines, of the weasel, ferret and mink types, are nervous and delicate as captives and require great care as to diet, requiring the flesh of small mammals and birds. They are unable to long survive upon a diet of meat with heavy muscular fiber, such as beef.

Possibly the most interesting among our mustelines is the otter. It lives for years upon a diet of fish. This particularly keen and intelli-

(*Continued on page 127*)

African civet, *Civettictis civetta*. One of the larger members of the *Viverridae*, an old world family, of which the well-known mongoose is a member.

Binturong or bear "cat", *Artictis binturong*. Largest member of the *Viverridae*. The combined head and body of a large example are close to a yard in length. The species occurs from southeastern Asia to Sumatra, Java and Borneo.

Meerkat, *Suricata suricatta*. There is a fair variety of small viverrines in Africa. This species inhabits the southerly portion. It is characterized by its elongate and pointed snout.

Suricate, *Cynictis penicillata.* A South African viverrine, immediately related to the mongoose group, although the limbs are comparatively longer. It preys upon snakes, lizards and small rodents.

Fisher, *Martes pennanti*. A North American musteline, occurring in northerly latitudes from the Atlantic to the Pacific coast. Its color varies from lustrous black to dark brown.

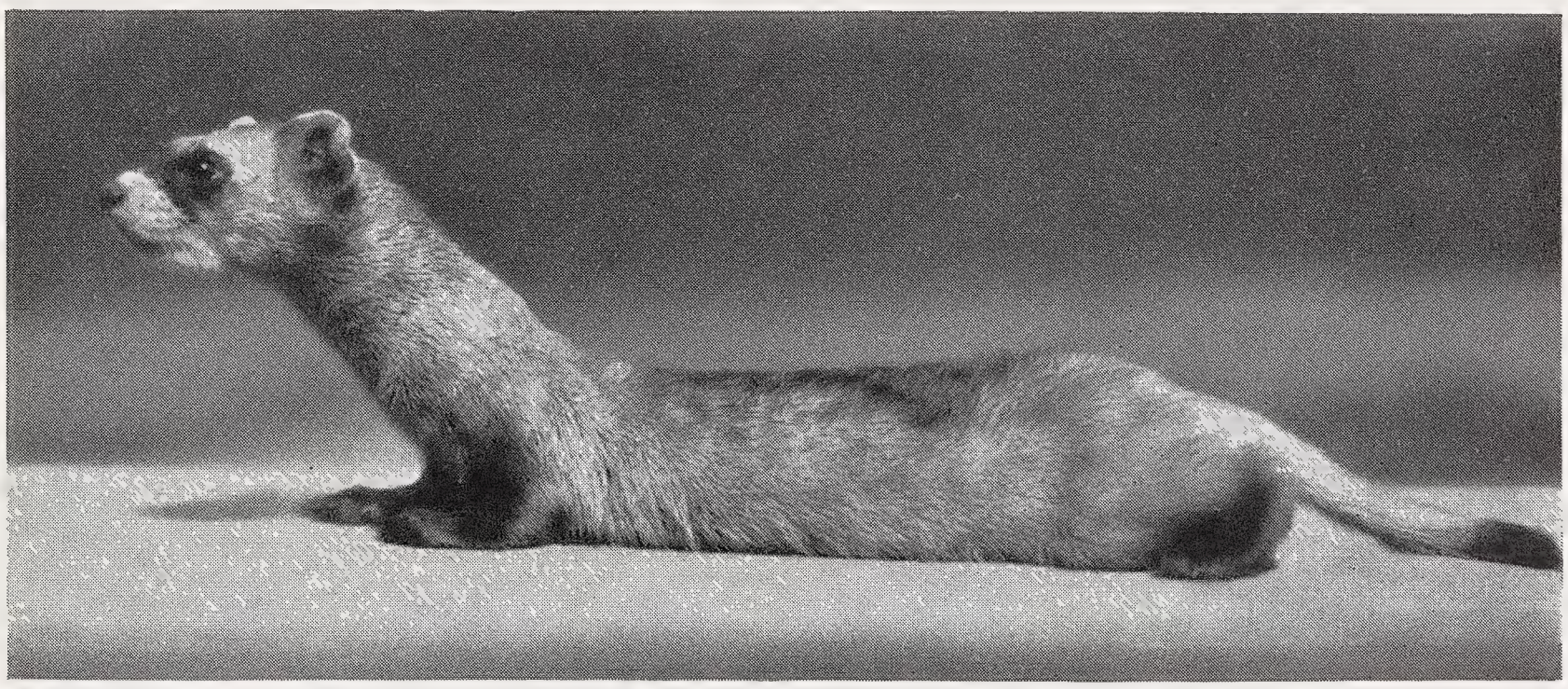
gent animal, in its rapid and graceful swimming antics, and its play, forms a most attractive exhibit. The several kinds of otters are strongly characteristic among the carnivores in the elongate, flattened body, wide and flattened head on stout neck, showing little differentiation between the two and the webbed feet. Here is ideal adaptation of the musteline form for a semi-aquatic life. Similar forms of otters occur in both the Old and New Worlds, in North and South America, Europe, Asia and Africa, all embraced within a single genus (*Lutra*) except a remarkable sea otter inhabiting both shores of the northern Pacific.

In contrast to the prevailing influence among the mustelines to develop slender, elongated forms of the weasel, mink, marten, fisher and otter types, are the badgers, New and Old World, with stocky bodies and powerful limbs for digging. The honey badger or ratel of Africa and southerly Asia, is a particularly strong and stout species. The wolverines of northerly North America and Europe, are the largest of the mustelines, savage and particularly strong; the length of body, including relatively short tail, is slightly in excess of forty inches and the weight up to thirty-five pounds. The strength of jaw of an adult specimen is astonishing. An example exhibited in the Zoological Park so strained and tore the heavy meshwork of its cage that it escaped. The cage was of a character that would have been estimated to have safely held a medium-sized bear. During our efforts to capture it—which were successful only after great difficulty—this animal fought with a strength and fury, and emitted growls worthy of a creature three times its size. Despite its goodly proportions and stocky form, the wolverine is closely related to the cosmopolitan genus containing the small and slender weasels.

Another family of small carnivores closely follows the mustelines in classification. This is the *Procyonidae,* containing the raccoons and their allies. They are more closely related, however, to the family of bears, which borders them on the succeeding descent of technical listing. This is an exclusively American family, containing the ring-tailed "cats" or bassarisks, raccoons, coati-mundis and kinkajous. There is much versatility in form among them, as evidenced by the stout-bodied raccoons, the excessively long-snouted coatis of tropical America, and the cat-like kinkajous, with their dexterously prehensile tails.

The Panda, one of two species forming the family *Ailuridae*—closely allied to the bears—may be said to be the most attractive small carnivore ever exhibited in our collections. The head of this species appears on the cover of the present number of the Bulletin. This animal is much the size of a raccoon, but with long, luxuriantly-haired tail. Its general coloration is bright reddish hue, the tail vividly ringed with black. The face is in startling contrast, being very white, as if the animal had thrust it into a flour barrel. The panda is an exceptionally gentle animal.

It occurs in the eastern Himalayas. The illustrations, following a nearly similar continuity of the order of the text, are from photographs of the smaller carnivores exhibited in the Zoological Park.



Black-footed ferret, *Putorius nigripes.*

Eastern weasel, *Mustela noveboracensis*. A number of species of weasels inhabit the United States, Canada and Alaska. The genus is also well represented in the Old World. The above example is in winter pelage. In southerly latitudes the weasel remains brown throughout the year.

Upper. American Black-footed ferret, *Putorius nigripes*, in pose showing the characteristic elongated form of many members of the Mustelidae. *Lower*. American mink, *Mustela vison*.

Wolverine, *Gulo luscus*. Largest member of the weasel family (the *Mustelidae*). Its form is robust and bear-like. The total length of a large male is about forty inches and the weight around five pounds. The species is savage and extremely powerful in proportion to its size.

Upper. Common skunk, *Mephitis mephitis.* Typical examples of a species inhabiting the greater part of the United States and Canada. Allied species occur in various parts of North America. The skunks are members of the *Mustelidae. Lower.* Common skunk, *Mephitis mephitis.* Indicating variation in the white markings.

Ratel, *Mellivora ratel.* A nocturnal and powerful, burrowing musteline, of South Africa.
The total length of a large example is about a yard.

Honey badger; Ratel

American badger, *Taxidea taxus*. Badgers represent the *Mustelidae* and inhabit North America, Europe and Asia. They are heavy-bodied, strong animals excavating deep burrows. Note the digging claws on lower figure.

Canadian otter, *Lutra canadensis*. A number of species of otter inhabit North and South America, Europe, Asia and Africa. They are characteristic among mustelines in being largely aquatic, with extensively webbed feet.

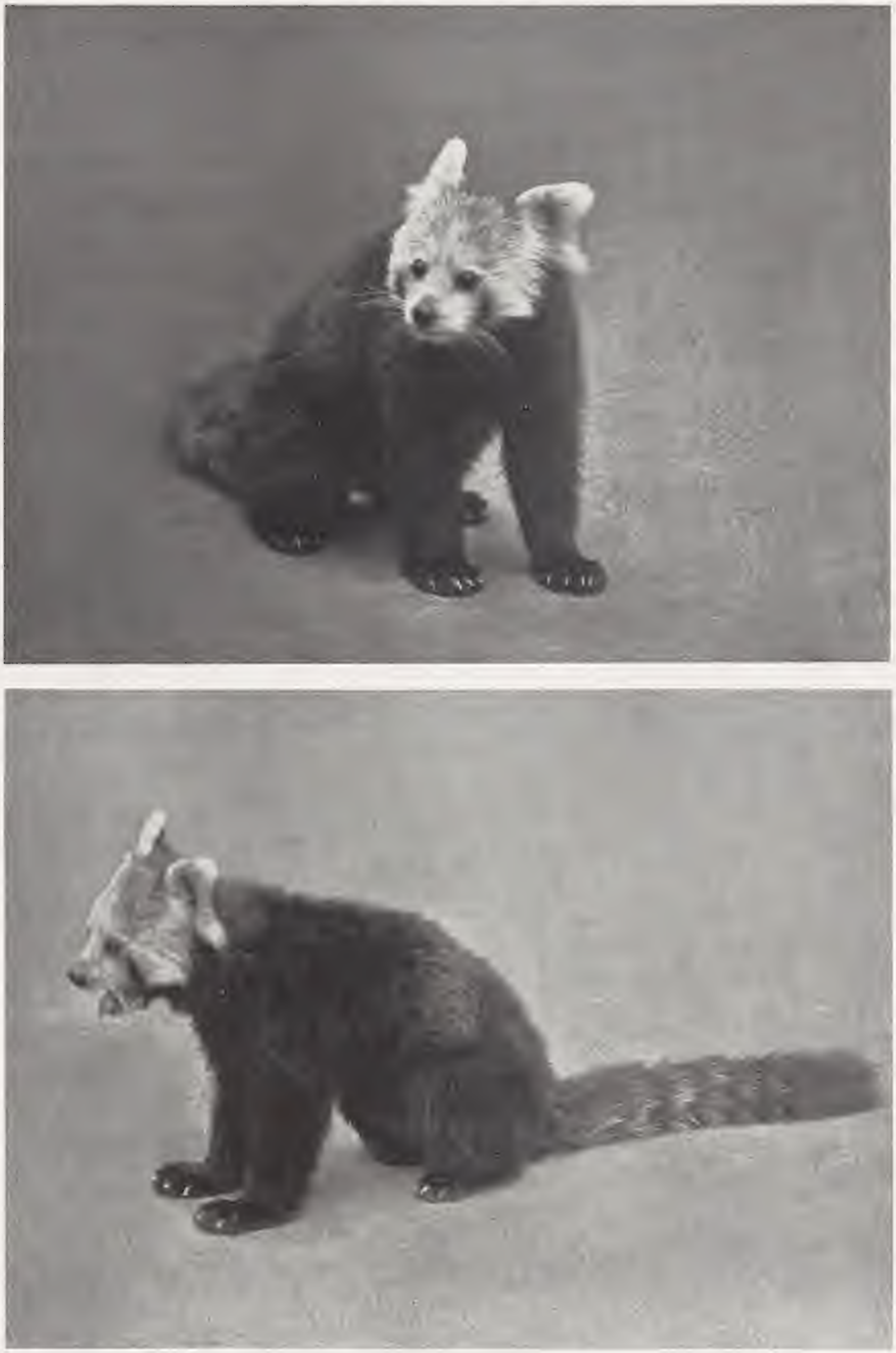
Crab-eating raccoon, *Procyon cancrivorus*. The family *Procyonidae*, containing the raccoons, ring-tailed "cats", coatis and kinkajous, is represented only in the New World—North and South America.

Eastern raccoon, *Procyon lotor*. *Upper*. The typical form shown above inhabits North America, east of the Rocky Mountains, from southern Ontario and Manitoba to Florida. There are a number of subspecies. *Lower*. Albino example of the eastern raccoon.

Ring-tailed "cat"; cacomistle, *Bassariscus astutus*. A small ally of the raccoon inhabiting the southerly United States from Louisiana to California.

Upper. Coati mundi, *Nasua narica*. (Immature example). Occurs from southerly Mexico to Peru. *Lower*. Ring-tailed coati, *Nasua nasua*. A species confined to tropical South America.

Kinkajou; Honey "Bear", *Potos flavus*. A prehensile-tailed member of the family including the raccoons and coatis. A particularly docile animal, of soft fur and cat-like form. It inhabits Central and South America.



Panda, *Ailurus fulgens*. Considered to be closely related to the bears. It is raccoon-like in form and size and inhabits the Eastern Himalayas. The white, fluffy hair of the head and upstanding ears, form a sharply contrasting note against the dark pelage of the body.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

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Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-five volumes completed. Volume XXXVI in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
Post-cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park.
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For all Aquarium publications or any work relating to Aquatic Life, address the New York Aquarium, *Battery Park, New York City.*

A completely classified list of the publications of the Society, with the subject headings of the various articles printed in the Reports, Zoologica, Zoopathologica, and re-prints from them will be furnished on request. Some of the publications have become exhausted and orders for any issues will be governed by this circumstance. Back numbers of the Bulletin can not be supplied. Address: H. R. Mitchell, *Mgr., Zoological Park, 185th St. and Southern Boulevard, New York City.*

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Vol. XXXVI, No. 6

Contents

November-December, 1933

WORK OF THE AMERICAN BEAVER IN THE ZOOLOGICAL PARK .....*Frontispiece*

THE RODENTS OR GNAWING ANIMALS .....*Elwin R. Sanborn* 143

DEVELOPMENT OF THE SILKY MARMOSET .....*Raymond L. Ditmars* 175

Illustrations

Flying Squirrel
Gray Squirrel
Fox Squirrel
Malabar Squirrel
Chipmunk
Thirteen-lined Spermophile
Prairie Dog
Woodchuck
Albino Woodchuck
Sewellel
American Beaver
Muskrat
Kangaroo Rat
Egyptian Jerboa
Spring Hare
Crested Porcupine
Indian Porcupine
Canada Porcupine
Albino Canada Porcupine
Yellow-haired Porcupine
Brazilian Tree Porcupine
Hairy Tree Porcupine
Hutia
Coypu
Branick's Rat
Paca or Spotted Cavy
Golden Agouti
Viscacha
Capybara
Texas Jack Rabbit

BRAZILIAN TREE PORCUPINE .....*Cover*

BULLETIN

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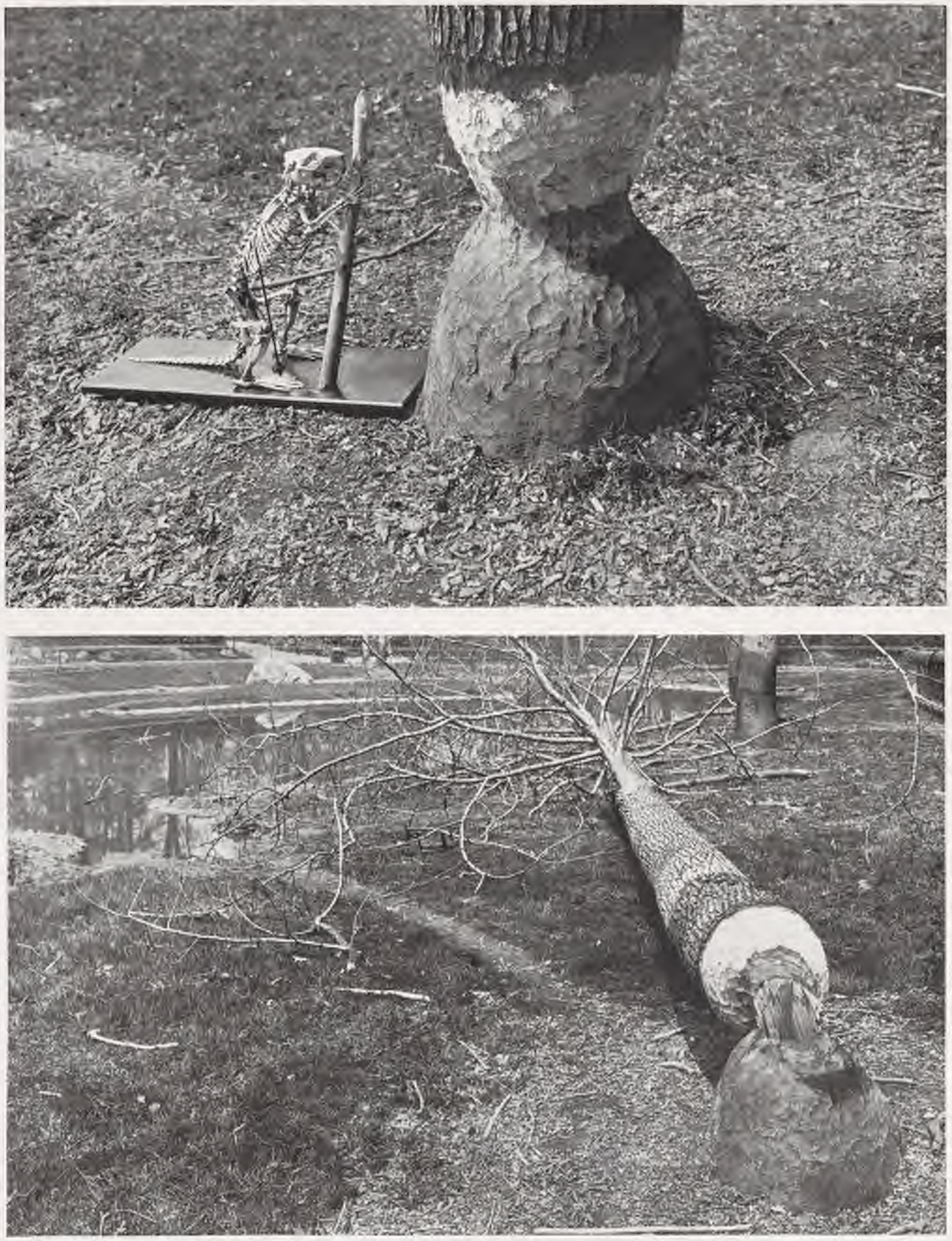

Tree-cutting by the American beaver, *Castor canadensis*, in the Zoological Park. This is an interesting feature of beaver life, and in all logging operations if the conditions are favorable, beavers seldom fail to cut trees upstream and float them down. Should it be possible to choose the tree, he will demonstrate that he is a conservationist of energy by picking them of small diameter, but there are records of beaver-cut trees of over thirty-six inches in diameter. The skeleton of the beaver in the picture was prepared for Mr. Sanborn for the purpose of comparing the size of the beaver with the task that he might attempt. The beautiful precision of cutting and instinct of proper felling direction are apparent.

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The Rodents or Gnawing Animals

By ELWIN R. SANBORN

Legends, and Photographs (except as otherwise noted), by the Author

THE order *Rodentia,* including the rodents or gnawing mammals is by far the largest, well-defined group of the world's mammals. The order is so definitely characterized by peculiarities of the teeth that, with one or two exceptions, even a casual inspection of the skull is sufficient to decide whether or not an animal is a rodent.

The teeth are of but two kinds, incisors and grinders—or molars, and the number of efficient teeth of the former is never more than two in each jaw. There are no canine teeth and since there are but two incisors, the front pair, there is a toothless space between them and molars on each jaw. But two exceptions occur among the order in this arrangement and distribution of the teeth: The hares and the little chief pika, have two extra incisors in the upper jaw, lying directly in back of the top pair, but they are quite useless in the process of gnawing for which the latter are so admirably suited. Their presence is of interest as a possible indication of the direction in which an alliance with other forms might be traced. The great incisors possess no roots, but spring from a permanent pulp, so that they continue to grow throughout the whole life of the animal. Their shape and that of the cavity which makes their socket, is invariably a segment of a circle, consequently they protrude from the jaws always in the same direction and meet at the same angle. To the layman, the great power of the rodent jaw must be apparent, as it might quite naturally be the creative pattern for the jaws of mechanics' plyers. The tremendous cutting force of the beaver's jaw is quite clearly shown in the frontispiece. On occasions, sometimes through injury, these great incisors fail to meet at the proper angle, and as a result the over-lap finally prevents the use of the jaws altogether, usually resulting in the death of the animal from starvation. They must meet, grind and be worn down to a chisel-like edge.

There is an extraordinary variety of rodents quite generally scattered over the greater part of the world. The order *Rodentia* includes more genera and species than any other existing order of Mammals. The reason for this may be because so many of these animals are of small size and timid ways. They secrete themselves in holes, hide in forest depths, in marshes or on the dry plains. They are generally nocturnal and invariably shrink from observation.

The largest and most typical family of the *Rodentia* is the *Muridae* which includes the rats and mice and their allies. There is a great variety in this assemblage of species but it may be said without fear of useless contradiction that the common rats and mice are characteristic types of the entire gamut of forms. The family also includes jumpers, leapers, swimmers, arboreal and burrowing species, and is practically cosmopolitan in its distribution. Most interesting of the *Muridae* is the lemming, numbering but a few species, one of northern Europe and the rest confined to the circumpolar regions of both hemispheres. The migrations of the Norway lemming is one of the most remarkable demonstrations of animal impulse yet known. They start in vast swarms from their mountain homes, thousands upon thousands, and make their way chiefly by night, obstinately in one direction, crossing mountains, swimming rivers and scorning any obstacle in their course. Even if they should reach the sea, they heedlessly plunge in, and the thousands of the army perish in the march of mystery.

The purpose of this article and this number of the Bulletin is not to give a complete history of the order of rodents, merely to set forth simply, some interesting facts concerning them, and present in picture a few of the species exhibited on occasion in the Zoological Park. Many others have been shown, but some of the Rodentia are next to impossible as photographic subjects.

The flying squirrel, *Glaucomys volans,* is one of "the most graceful and exquisite little mammals in North America", but its aversion to daylight and its nocturnal habits are a barrier to common acquaintance. The fur is soft and delicately fine. It differs from the ordinary squirrel principally in possessing a thin skin connecting the fore and hind legs which serves as a parachute and enables it to make long gliding leaps from one tree to another. The flying squirrel and certain lemurs similarly equipped do not fly, but rather soar, the stretched membrane giving lifting power against the air. A straight out flight is impossible. They are classed in the order of Rodents, family *Sciuridae*.

The gray squirrel, order of Rodents, family *Sciuridae, Sciurus carolinensis,* is one of the most commonly known of these lively and playful rodents. Because of his guileless and friendly manner he is the very king of beggars. He has adapted hmself to a life in public parks, and accepts without reserve or fear the proferred hand of good fellowship of man, as well as any food that might be offered. So fixed has become this habit that he has abandoned the custom of his ancestry in providing a store for winter, and lives a life of ease, almost wholly dependent on his supply of food from the cheerful giver. During the period of depression, it was even said of him by some modern Demosthenes, that the order has been reversed, he had turned to feeding the visitors. Photograph by E. R. Osterndorff.

Here is a familiar visitor to the officers and keepers of the Zoological Park, who in common with several others makes at least weekly, if not daily trips to the Park with a bag of food principally to feed the squirrels. By frequenting the same localities, the squirrels in that neighborhood not only depend on this friendly woman, but have learned to recognize her as well. In a brief time, once she appears, they usually assemble in considerable numbers, climb over her shoulders, and even enter her pockets and bag to find the food and if possible to get the principal part. The gray squirrel is an indifferent antagonist and prefers the peaceful life, which is a contrast to one of his relatives, the chickaree, the red squirrel, *Sciurus hudsonicus,* who makes up in activity what he lacks in size. Fortunately, the latter species does not frequent public parks, which is quite to the grays' good fortune since he is their relentless foe. Photographed by E. R. Osterndorff.

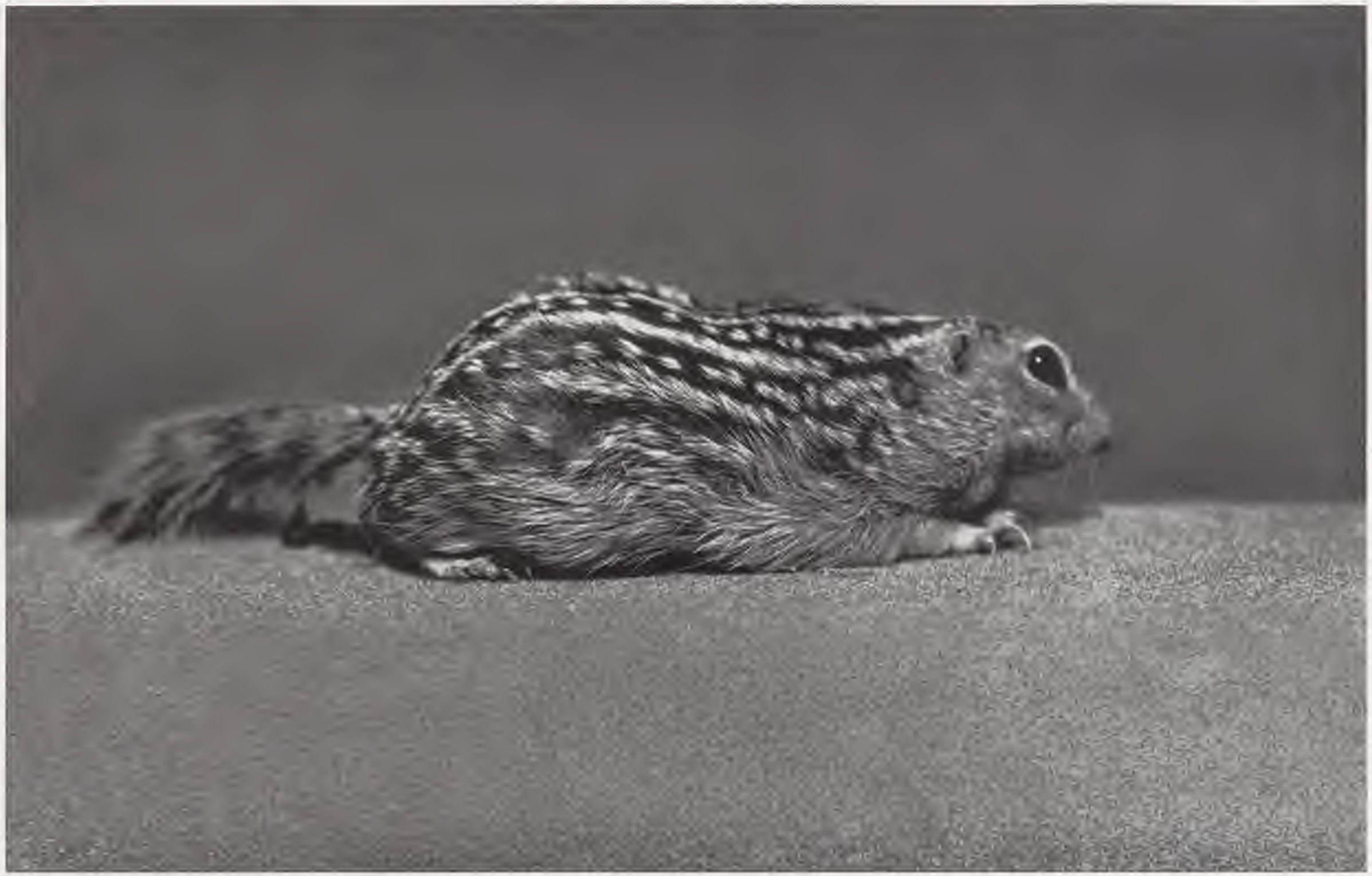
The gray squirrel is the most prominent squirrel of Southern Canada, New England and the eastern and southern states southward to Florida, and ranges westward to Minnesota, Kansas and Texas. Usually it nests in hollow trees and also builds an open round structure of leaves and bark high among the branches. The young are born in the spring and are solicitously cared for by the parents. While the food of the squirrel is chiefly roots, nuts and buds of trees, some species suck the eggs of birds and even eat the young. Australia, that land of anomalies, is one place in which the squirrel is not found. The albino squirrel in the upper picture lived for a number of years in the office of the late G. O. Shields on 5th Avenue, New York. A gray squirrel is found in California and Southern Washington which is somewhat larger than the eastern types. Lower photograph by E. R. Osterndorff.

A distinguishing feature of this squirrel, the fox squirrel, *Sciurus niger,* is the white nose and ears. Dr. Hornaday in one of his books says, "no matter how much the animal may vary in color from the standard, the adults invariably have the white nose and ears." It is a large squirrel, the largest of the American species, having a combined length of two feet or more, one half of the length being the very bushy tail. The range of its habitat is east of the Allegheny Mountains, from Virginia to Florida and west along the Gulf as far as Louisiana. Its northern relative is slightly smaller, somewhat similar in color, but the nose and ears are never white. At times specimens have been liberated in the Zoological Park, where they have thrived for a while only to eventually wander off or die. The range of this species is northerly as far as New York and Michigan.

The brilliance of the tropics extends to the mammals as well as to its other living forms, and while the color patterns may not be of so extensive a prismatic range, they are brilliant against the somber shades of the temperate zones. Besides being gayly colored, the squirrels of the tropics also excel in size those of colder climes. The Malabar, *Sciurus malabaricus,* one of the most attractive species, inhabits the Nilgiri Hills of India and the nearby territory and attains a length of over three feet, the tail being at least eighteen inches of that measure. The general color-pattern of the body is a rich maroon-chestnut shade with the under parts of warm yellowish buff. Parts of the legs and the magnificent tail are glossy black. Several closely related species are brightly colored. The Malabar is most amiable in captivity, is gentle, sociable and altogether a satisfactory charge.

The chipmunk, an Indian name, is a small squirrel-like rodent, somewhat smaller than the true squirrel, from which it also differs in having internal cheek-pouches and stripes on the back and sides. It is further characterized by its somewhat subterranean habits, living either in a burrow which it constructs under the bases of trees, a huge boulder or some site which its keen instinct prompts as a safe shelter. The chipmunk is a prodigious and persevering worker, and lays up a great store of nuts, grain and fruit pits for the winter months. These he collects in his cheek-pouches and empties into his storehouse. As soon as the cold seasons approach, this wise little animal goes into winter quarters and there he remains until the warm suns of spring beckon to him to appear. In the very depth of winter they lie dormant in their nests, warmly lined with leaves and grass. The young are born in the spring. The specimen shown is the common eastern chipmunk, *Tamias striatus*. Photograph by E. R. Osterndorff.

The chipmunk has so many persistent enemies that pursue him both above and below the ground, that it is quite natural for him to be shy and suspicious. But constant practice in dodging danger has given him, not only uncanny skill in evading peril, but some measure of discernment of the intentions of the supposed friendly hand. So insidious is habit that he has learned to be a conserver of his own energy, set aside instinctive suspicion and accept the fellowship of man in satisfying the immediate need and possibly, if the charity is ample, laying up a store for winter. In the Zoological Park, where these two pictures were made, it is quite common to observe visitors feeding this usually very timid animal. The generic name *Tamias,* is from the Greek, meaning steward and refers to the chipmunk's habit of laying up food.
Photographs by E. R. Osterndorff.



The word spermophile is derived from two Greek words—*sperma,* seed and *philos,* loving, and as this very appropriate term implies, the animals so designated feed chiefly on seeds and grains. Because this little animal does not discriminate between the wheat and the tares, he has created trouble for himself and found an enemy in man. It is the common name for an extensive group of ground-squirrels found throughout western North America, living by preference on the open prairies in deep and extensive burrows. They are social animals, laying up food for the winter, and in cold latitudes hibernating throughout the period. Besides seeds and grains, the spermophile consumes enormous numbers of insects, and, from actual observation, it has been ascertained that in season insects form the major part of their food. Nature has so adjusted the life of this animal that it can survive the rigorous winter of its habitat in the strange condition known as hibernation. In a specimen examined there was no visible breathing, the heart beat reduced from 200 to 4 feeble beats the minute, and the nerves were insensitive. The picture is the thirteen-lined spermophile, *Citellus tridecemlineatus,* the latter name indicating the number of stripes along its sides.

The prairie "dog", *Cynomys ludovicianus,* probably acquired the common name from the French Canadians who designated him "petit chien", little dog, because of the similarity of its sharp bark to that of a dog. Otherwise he is quite unlike a dog. Entirely gregarious, they dwell together peaceably and often in colonies of considerable numbers. He is a burrower of ability and persistence. The mouth of the burrow is a mound like a miniature volcano, and during the social hour the owners perch thereon and survey their small world. Some of the "dog" villages on the open prairie are almost unbelievably denuded of grass and the soft vegetation upon which they feed. It is not true that rattlesnakes and owls live in harmony with the "prairie dog". The snakes would devour the young, and any mammal instinctively avoids a rattlesnake. Possibly owls dwell in deserted burrows, but it has been proved that they cannot live in the same burrow with the prairie dog. Dr. Hornaday mentions a burrow actually dug out that went down vertically fourteen and a half feet, then turned abruptly a horizontal distance of thirteen and a half feet. Photographs by E. R. Osterndorff.

A portion of the prairie "dog" village in the Zoological Park. This was one of the first outside installations constructed in the Park, and for nearly thirty-five years it has endured the test of time, climate and interest of visitors. A free colony was established in the antelope range which thrived beyond the aims and the restrictions which the Society expected. The open country proved too great a temptation for the industrious and ambitious "dogs", who commenced to wander beyond the edges of the domain of which they were unaware and heedless. Flower-beds and lawns soon erupted into "dog" mounds and the neighbors complained. Capturing the runaways was not so simple. It was easy to get one into his burrow, but to extract him was something else. Eventually this was accomplished by placing a small cask, open at both ends, over the hole and partially filling it with dry sand. When the occupant of the burrow dug himself out, the sand was in the hole and the "dog" was in the barrel. Just a fair change. Photograph by Ernest Keller.

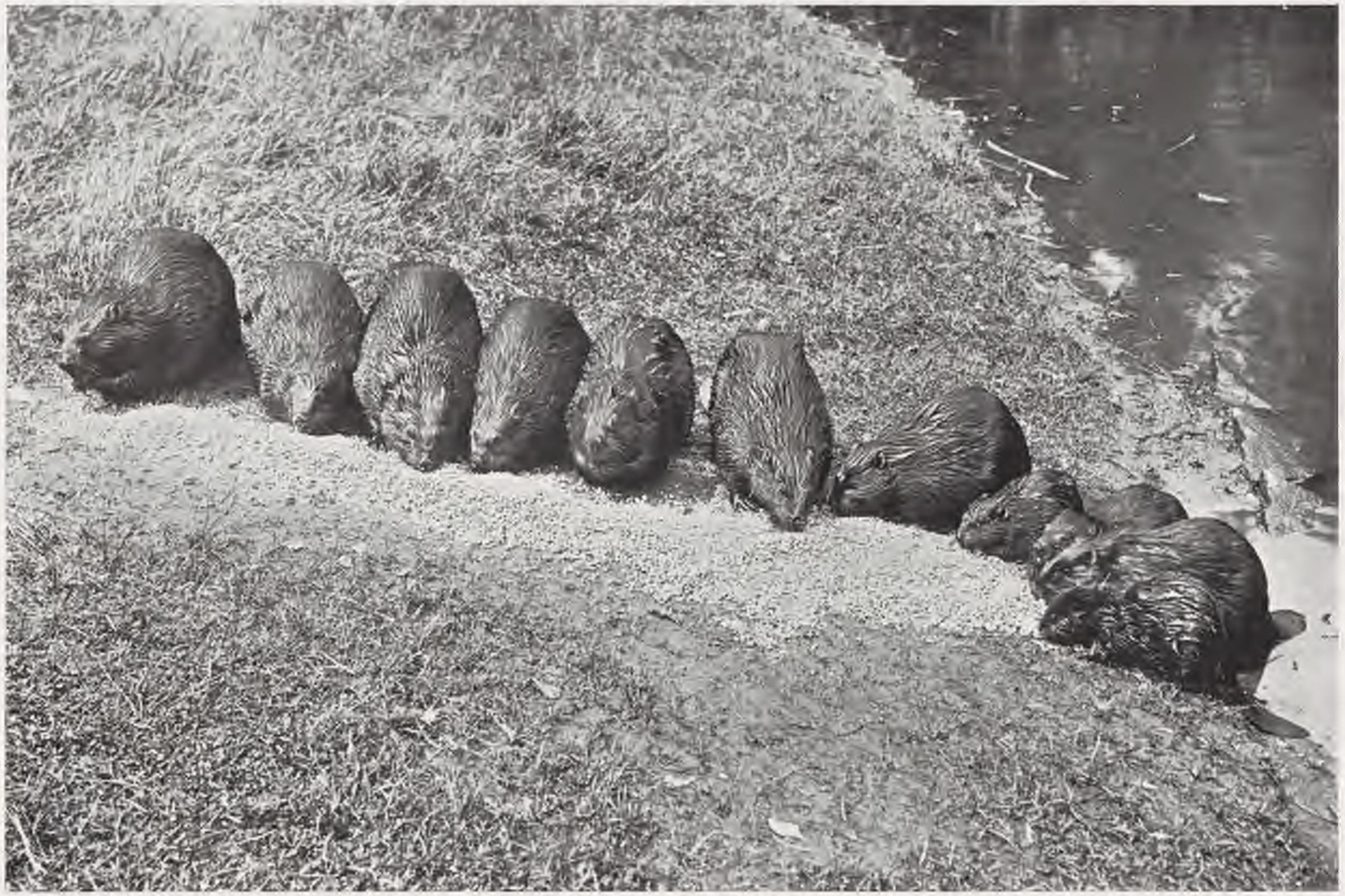
The woodchuck, *Marmota monax,* is our most perfect type of marmot, from which the prairie "dog" or prairie marmot is but slightly removed; the difference an anatomical detail. The woodchuck or ground "hog" as he is commonly called, is quite generally known from Hudson Bay to Virginia and westward as far as Nebraska, and is the most common of several species found in North America. He is a good burrower and digs deeply in the fields, sides of hills or under rocks in the woods, making several apartments slanting upward to keep out the water and most usually with more than one entrance. In his diet he is strictly a vegetarian, partial to red clover, but will accept any green food, which he eats sitting erect like a squirrel. They are both nocturnal and diurnal in their habits, feeding time being determined by the period and the temperature. When taken young they are easily tamed and being cleanly in their habits they make interesting pets. The name *monax* means solitary, an indication of its habits. Upper photograph by E. R. Osterndorff.

The woodchuck hibernates in the winter, the duration depending on the latitude. It is one of the earliest to go into winter quarters and one of the first to come out in the spring, the length of its hibernation varying, being longer in its northern habitat than in the south. It is possible that in certain latitudes, the woodchuck lays up a store of food for winter consumption, but when the hibernating period is protracted nature provides a better way. If the living is good throughout the summer, when fall cames around he has acquired a great store of fat next to his skin, and when the first chill winds give warning he enters his burrow and goes to sleep. His coat of fat not only acts as a blanket, but serves to nourish his body throughout the long dormant period. According to tradition he does not emerge until February second, when if he sees his shadow, it indicates more winter and he retires for another six-weeks sleep. Albino phases often occur among mammals and birds; this is a good example.

The sewellel, *Aplodontia rufa,* is a little known and rarely seen marmot-like burrowing rodent, found along the Pacific coast north of California, and exhibited but once in the Zoological Park. It is a small animal about twelve or fourteen inches in length, with a head much like the beaver, and strong short legs adapted to its burrowing habits. It is not aquatic, but feeds like the beaver, usually on water plants. They are shy and timid, live sociably in colonies in burrows constructed in moist ground where water is plentiful. Indians greatly prize the skins, and capture the animals by setting traps in the water, taking advantage of its aquatic feeding habits. Sewellel is the Indian name, but it is also called mountain beaver, showtl and boomer. Several other species are known in the Sierra Nevada Range. A distinguishing anatomical feature is the structure of the molar teeth, which are simple and not grooved.

"The beaver easily leads the mammals of the world in mechanical and engineering skill and also in habits of industry". It is the largest gnawing animal in North America, specimens having been known to weigh fifty pounds or more. It is so exceedingly shy and timid that the opportunities of seeing the beaver at work in the wilderness have been given to those only who have exhaustless patience and time, even in the Zoological Park where it might be supposed that animals would become accustomed to observation, the beaver is known usually only by the traces of his work that he leaves behind, or the labels that briefly state his history. The broad, flat and usually hairless tail is distinctly a beaver feature, and by it he may be easily recognized. Many stories have originated concerning its purpose to the beaver, but its use as a trowel in dam-building, which is one, is quite surely a myth. The large hind feet are webbed and used for swimming, the tail aptly aiding to change direction, and also to give warning by a quick hard slap on the water.

Top left; shows a beaver idly floating as they do when sensing danger. *Top right;* young beaver coming out of the pond. *Center left;* a beaver dragging small timbers into the dam. *Center right;* alarmed beaver diving, the geyser indicates the warning slap of the tail. *Lower;* how the beavers filled the sluiceway in the dam.



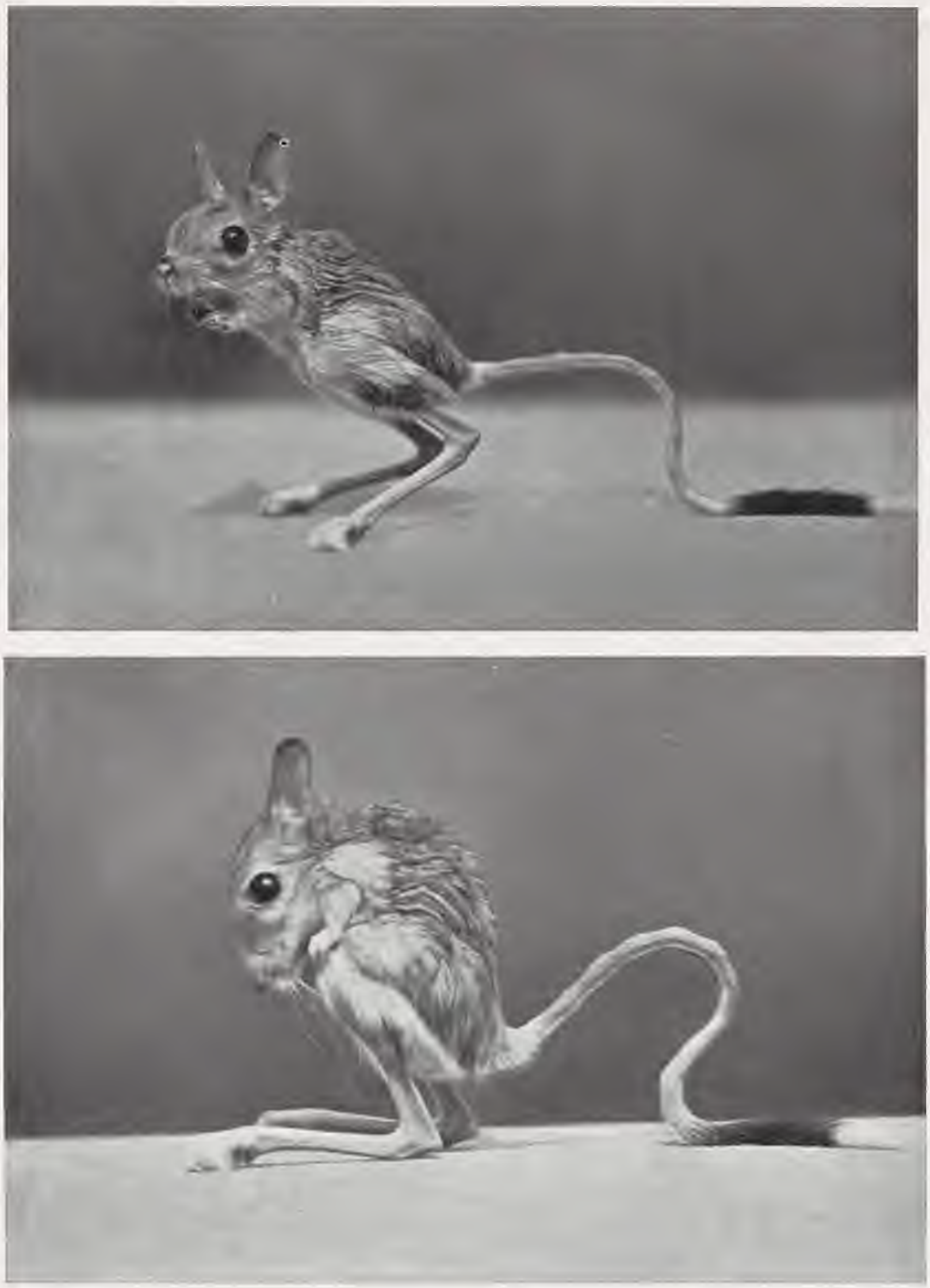
The food of the beaver consists chiefly of the inner bark of the wood of the aspen, willow, birch, alder and a few other trees, and also on occasion berries, mushrooms, grasses and the leaves and stalks of plants. Beavers are vegetarians, eating no flesh of any sort. Their supply of food for the winter consists of cut lengths of their favorite food-woods sunk in the pond around their dwelling, and to which they have access by diving under the ice surrounding the lodge. He is a most skilful diver and swimmer and can remain under water for several minutes. When swimming the fore-paws are folded against the body, the hind legs doing the propelling while the tail acts as a rudder. This unusual picture of beavers—eleven in number—was made in the Zoological Park by Dr. R. L. Ditmars, using good field corn for bait. Different beaver families do not mix well together, which makes this collection seem like relations.

The beaver is very cleanly in his habits and reserves time out to work over his toilet. When not feeding or working, he sits soberly on the bank and gives much attention to combing his fur which is done with the long claws of the fore-feet. Beavers do not hibernate, but in the winter months they sleep longer and move about less frequently than in other seasons.

The muskrat, *Fiber zibethicus,* an American rodent is also known as musquash and musk beaver. It is quite rat-like in appearance, but its flat, hairless tail is carried on its edge. It is found all over North America from one side to the other and invariably near streams, ponds or any bodies of water as it is entirely aquatic. It raises mound-like houses of vegetation in marsh lands in which several families live quite peacefully together. The muskrat breeds rapidly and prolifically which is quite lucky for him as many rapacious animals love his musky flesh and his pelt under various disguises is sold as a costly fur. He will never be found far from water and although the feet are slightly webbed, the tail seems to furnish the motive power in swimming. The name *Fiber* means beaver and the specific name refers to the rat's musky odor.

The cheek-pouch or pocket mice and rats comprise a family solely of the American west and southwest, its members being found only beyond the borders of Arkansas, Iowa and Minnesota. Many of the species are desert dwellers and are distinguished from other North American mammals, except two species, by the external, hair-lined pouch which is part of the skin of the cheeks. This very useful feature is sufficient at least for recognition of any member of the family. The Kangaroo Rat, *Dipodomys agilis,* which is in a genus including over forty species and races, is a most graceful and attractive little rodent. Dr. Hornaday says, "In the dry and sterile regions of the great Southwest where seemingly the deserts produce nothing but sand, cacti, yucca and sage-brush, these pert little creatures hold forth". Apparently they are both fire-proof and water-proof, since no amount of heat affects them, nor are they inconvenienced by the lack of water. Some species build large mounds of dirt and gravel often of large proportions which are filled with galleries and runways. Desert rattlers frequent these mound dwellings, no doubt finding the owners a good item of food.

The large external cheek pouches are clearly shown in the upper picture.



The jerboas, family *Jaculidae,* are mouse-like rodents with tail and hind legs nicely developed for leaping. The forelegs are of hardly any use except for holding purposes. They are natives of Asia and Africa, and some range into southern Europe. The Egyptian jerboa, *Jaculus jaculus,* the most thoroughly known, is gregarious, living in colonies in northern Africa, which extend as far as Syria and Arabia. The fur is delightfully soft and silky and a pleasing color combination of pinkish gray and fawn accented by snowy white and rich blacks. Ancient people called this little animal "two-footed mouse" because the legs are held so close to the body in leaping that they are almost invisible and lend a bird-like appearance. Even a casual examination of these pictures would be sufficient to convey the impression of unusual leaping powers; indeed the body seems overpowered when it is compared with the hind legs and the spring-like tail. The large luminous eyes and the gentle expression would disarm the hardest hearts, yet the Arabs who are fond of its flesh slay them in numbers. It is indeed so "that a hungry stomach hath no eyes".

The jumping hare, African spring-hare, *Pedetes cafer*, is the only representative of the family *Pedetidae*. The spring-hare differs in so many respects from the true jerboas that it has been made a separate family. It is way beyond the size of the jerboas, being at least two feet in length, about one-half included in the bushy tail. Its habits are much like those of the jerboa and the range is quite general over South Africa. The flesh is greatly esteemed by the Dutch of South Africa and the fur which is long, soft and of pleasing color is used in making wearing apparel. The ease and grace with which these kangaroo-like mammals move is truly an interesting performance and the speed attained when they are thoroughly alarmed is quite astonishing. For short distances they barely touch the ground, this interval only a fraction of the time of the long smooth leap. Once in motion, they skim low above the ground with a bird-like flight.

Porcupine, derived from two Latin words, *porcus*—hog, and *spina*—thorn is the common name for an interesting group of rodents, dwellers of both the old and new worlds. The true porcupines of southern Europe, middle and southern Asia, and also Africa, live in burrows of their own construction or in caves among the rocks, and next to the beavers are the largest rodents of the old world. They are terrestrial, living altogether on the ground; in this characteristic they differ from their American relatives, many of which are entirely arboreal, and all climbers of ability, slow but positive. The crested porcupine, family *Hystrichidae,* is the common porcupine, *Hystrix cristata,* of North Africa. If disturbed, the quills which are ordinarily somewhat depressed, instantly become erect, presenting a formidable barrier to an enemy. The species shown at the top is the crestless porcupine. *Hystrix longicauda* of India.

The Canada porcupine, family *Erithizontidae*, the common porcupine, *Erethizon dorsatum*, is the most generally known of the American species. Native of the forest of eastern North America, from Labrador south to Virginia and westward to the Rockies. The porcupine is clumsy, slow, an easy climber, and inoffensive until it once gets its back up. Easily captured or killed by man, one would think him doomed to quick extinction. He is not very formidable, having neither dangerous claws nor jaws. Living in the vicinity of flesh-eating mammals, he continues placidly indifferent and quite undisturbed. A bear, lynx or any other predatory animal would sooner take the big risk in a farmer's barnyard, rather than trifle with a fat easy-going porcupine, and all because of the host of sharp barbed spikes thickly set among the hairs of his coat and tail. These quills are so fastened to the skin, that they readily detach and stick in quantities into hostile jaws and paws, clinging tenaciously and painfully. Pumas and other predatory animals have often been killed in starving condition with their lips, tongue, jaws and roof of mouth so filled with quills that they were unable to eat. The porcupine is not an attractive morsel to any forest prowler.

The young of the porcupine are born in the spring, usually two in number, but occasionally there are three or four; the nests being in hollow trees or holes among rocks. The little ones appear with their eyes open and bodies covered with soft flexible spines, which harden soon on exposure to the air. If taken from the nest they are readily tamed and soon learn to know the persons caring for them and become docile and interesting pets, and never show their spines. As infants, they instinctively know the dog as an enemy, and instantly erect their tiny quills and swell with anger when one approaches. The dog that once has had his nose filled with quills from a porcupine's tail, seldom cares to try it a second time.

The quills of the porcupine are really thick, sharp and pointed hairs, and plainly are not useful as covering, but are solely a defensive armature. They are so distinctly a striking feature that it has created in imaginative minds strange ideas of the reason for their existence and the powers that the porcupine might possess in their management. A popular theory is that they can be cast in any direction. The owner can do nothing more than erect the spines and rattle them briskly, and possibly when he does so some may fall out or be tossed aside by the vigor of the movement. When irritated or badly frightened the quills are erected and present a formidable barrier to an enemy. The Canada porcupine strikes a quick sideways blow which if it lands drives the quills into its enemy. The legend that the porcupine shoots his quills is utilized in the coat-of-arms of the French king, Louis XII, which bore armorially a porcupine with the motto, *"Comminus et enimus"*—prepared for enemies close at hand and at a distance.

The pictures show rear and side views of an immature albino Canada porcupine.

The yellow-haired porcupine, *Erethizon epixanthum,* ranges beyond the Missouri river westward to the Pacific slopes. It may be smaller than the Canada porcupine, but unless the subject of this photograph was an unusually large specimen, that statement seems to be incorrect. By comparison with the cap which was put there for that purpose, a very definite idea may be had of his truly huge size. Also it shows the typical form and the well-developed coat of hair, much more ample than that of the Canada porcupine on page 166. The food of these porcupines is entirely vegetable, and it is especially partial to the inner bark and tender twigs of the elm, basswood and hemlock. Once they climb into a tree to feed they seldom leave it until the bark is entirely denuded. In riding the trails in the mountains of the far west, these gaunt, white, bark-stripped trees stand out as monuments of porcupine perseverance. They love to prowl around hunters' camps, where they will devour scraps of any food, bits of leather or even greasy boards.

The tree porcupines are found wholly in America, and differ from the old world porcupines in many ways, but chiefly in their arboreal habits. There are several species all with somewhat slender forms, usually having long tails which in most cases are prehensile. The Brazilian tree porcupine *Coendou prehensilis* (upper), as its name indicates, is found in Brazil and also in Guiana and Bolivia. The spines of this species are thick and project well above the fur. It is almost entirely arboreal, seldom leaves the trees and is quite inoffensive. The natives hunt them for their flesh which they regard rather highly. The lower picture is the hairy tree porcupine, *Coendou villosus,* and is found in Brazil. A species of tree porcupine, *Coendou mexicannum,* is found also in Mexico. It attains a rather large size with a tail about twelve inches in length which is prehensile. Lower photograph by E. R. Osterndorff.

The hutia or tree rat, *Capromys pilorides,* from the West Indies, resembles the coypu in general appearance but is more rat-like and arboreal in habits. There are several species in Cuba, one in Jamaica and one in the Bahamas. The hutia lives in dense forests and subsists mainly upon fruit, leaves, insects and small animals, especially lizards. It is frequently kept as a pet and its flesh is eagerly sought by the natives. Photograph by E. R. Osterndorff.

The coypu rat, *Myocastor coypus,* is a South American aquatic rodent of the family *Myocastoridae,* frequenting the lakes and rivers on both sides of the Andes from Peru southward. The coypu is about two feet long, has a long rounded tail, scaly and nearly hairless, and webbed hind feet like the beaver. With the exception of the tail, the body is covered with long dusky and brownish yellow fur with a dense and soft under coat. It is an excellent swimmer, lives in burrows in the banks of rivers and lakes, feeding on the foliage, seeds and roots of water plants. Quite prolific breeders, the female sometimes has been observed, with eight to ten young, some riding on her back and the balance swimming along behind. Great numbers are killed for the fur much used by hatters and known as nutria, the name of the coypu in the Argentine.

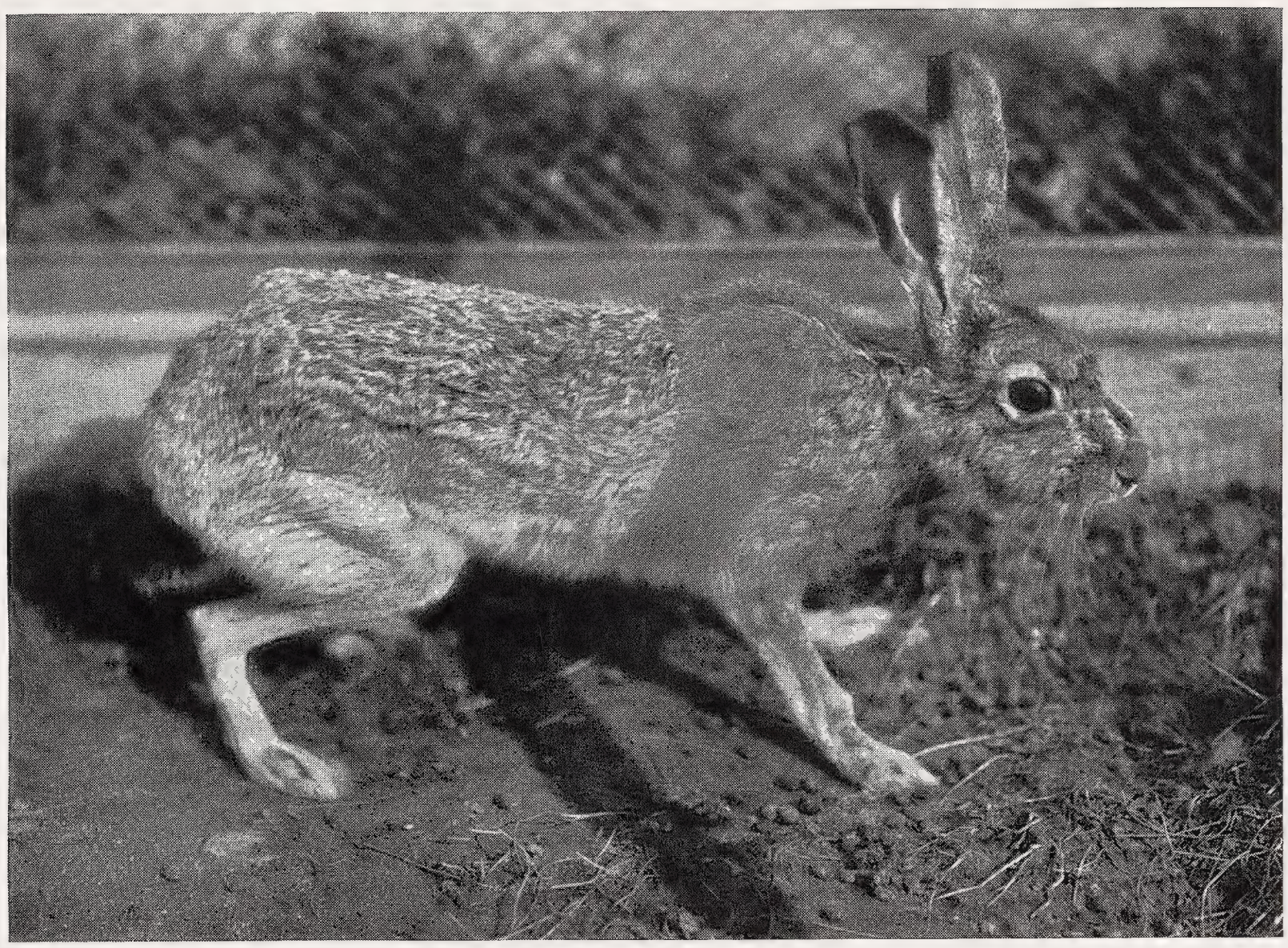
Branick rat, *Dinomys branickii,* is the sole representative of a family of paca-like animals. It closely resembles the paca but differs externally by having a rather long, hairy tail, four toes on each foot, and a cleft upper lip. It was described from a single specimen found in a courtyard in Peru. Nothing further concerning this animal was learned for over a quarter of a century. Recently, several specimens have been on exhibition at the Zoological Park.

The paca, sometimes called cavy, is a stout-bodied rodent allied to the agouti, indigenous to tropical America. It ranges generally over South America east of the Andes as far south as Paraguay and is found also in the islands of Tobago and Trinidad. It is a stout-bodied animal weighing fifteen pounds or more, with short stout legs, with five toes on each foot. The fur is coarse and short, yellow-brown above and tawny-white below, marked by five rows of yellow spots extending in rows from the shoulder to the rump. Its habits are like those of the agouti. He is strictly a vegetarian, living on fruits, leaves and the stems and bulbs of water plants; and when the opportunity is at hand invades cane fields and melon plantations. The natives trap him industriously, and he is hunted with hounds in Brazil as a sporting proposition. He is classified as *Cuniculus paca,* the generic name signifying that he is rabbit-like. Photographs by E. R. Osterndorff.

The golden agouti, *Dasyprocta aguti,* family *Dasyproctidae,* is a small rodent found in the tropics of Central and South America and in some of the West Indian Islands. It is a bit larger than a rabbit, with slender legs, five toes on the forefeet and three on the rear, with strong claws and has just the suggestion of a tail. The fur is a rich olive above, yellowish-white beneath, and the long hair on the rump is bright orange. Agoutis are forest-dwellers, nocturnal in habits and hiding out during the day in hollow trees or cavities in the ground. Their food is chiefly leaves, roots, fruits and nuts; their sharp teeth enabling them to cut the hardest shells. They are very graceful and strangely enough, excellent swimmers, an accomplishment acquired by the necessity of escaping from their enemies, particularly the ocelot. The flesh is prized for food and they are freely hunted. They quickly become tame if taken young and it is quite common to see them about South American dwellings.

The Viscacha, *Vizcacia viscacia,* of the family *Vizcaciidae,* is a small rodent of South America related to the chinchillas. Unlike the chinchilla, the viscacha dwells in colonies, in burrows on the vast grassy pampas east of the Andes, from Buenos Aires to Patagonia. The burrows are associated in numbers to form veritable cities, called viscacherias arranged to provide for the number of individuals in a family and with many entrances to make escape easy in times of stress. Though the colonies burrow in deserted places, they are usually near cultivated areas and the occurrence of these little viscacherias is an indication of the near-by settlement. These burrows render travel on the pampas very dangerous to horses and their riders, and the viscacha consequently is hunted mercilessly, the grass being burned to destroy their food and their burrows flooded to make them a prey for dogs. The Indians eat the flesh and use the skin, but the latter are not as valuable as those of the chinchilla.

Capybara is a native name for a huge aquatic rodent of South America, ranging over the eastern section from Guiana southward to the La Plata and in the lower parts of Peru and Bolivia. It is essentially aquatic in habit, and also has the distinction of being the largest living rodent, attaining a weight of at least one hundred pounds. He carries a ponderous variety of names of local derivation, such as carpincho, water pig, water hog, and water cavy. The body is thinly covered with coarse bristle-like hair, reddish brown in color. He has no tail and the feet, which are small by comparison with the great weight they support, four toed in front and three in the rear, have short webs. Capybaras are peaceful and quiet and as their sober solemn countenance would signify not in the least playful or sportive. Their natural food necessarily is indigenous to the river banks and marsh lands which they frequent, but they will take a chance when convenient to make raids on plantations of melons, maize, rice and sugar cane. It would indeed be a worthless creature for which man could not find a use. The capybara seems to fit this case; he has nothing much to offer but his incisor teeth, which the Indian girls string and wear as bracelets and necklaces. The capybara is classified as *Hydrochaerus hydrochoeris,* family *Hydrochoeridae.* Photograph by E. R. Osterndorff.



All the American members of the family *Leporidae* may be divided into two groups — the hares and the rabbits. A typical hare is a large, attenuated creature, long eared, long legged and a naturally swift runner. The young are reared in a nest. The rabbit is small, short eared, short legged, not a good distance-runner. Rabbits are gregarious living in colonies in "warrens" formed of many burrows. Hares are distributed generally over the world, except the Australian region, but are mostly confined to the northern hemisphere of both worlds. The species shown is *Lepus californicus texianus,* of the Southwest United States.

Development of the Silky Marmoset

RAYMOND L. DITMARS

THE following notes, so far as the writer is aware, cover the first observations on the birth and growth of the Silky Marmoset, *Leontocebus rosalia* (Linnaeus), in an American zoological garden.

In January, 1932, we acquired a fine pair of silky marmosets, and as this beautiful species is allegedly delicate in captivity, the pair was installed in a large cage, of light construction, in the Reptile House, near a double window with southern exposure. This arrangement gave the little animals long hours of sunshine, and during the winter months provided high and even temperature, and humidity approaching tropic conditions. A varied diet was provided, as in a wild state marmosets have been noted to feed on fruits, small reptiles and insects—in fact they are definitely insectivorous and the chitinous covering of insects appears to be a necessary part of the diet. Small lizards were also regularly supplied to the marmosets. They devoured them ravenously.

Under these conditions the marmosets thrived, and early in March it was noted that the heavy condition of the female indicated that she was carrying young. As manifestations of breeding had been lacking, we were unable to figure on a period of gestation.

On the 26th of April, 1933, twin marmosets, a male and a female, were born. They were surprisingly large in comparison to the size of the mother, my estimate of the combined length of head and body being approximately three inches. The head was relatively large and heavy, the body weak and slender. The young were clad in lustrous yellow hair, of paler hue than that of the parents. They clung tightly to the mother, the inclination being to encircle her lower body. From this commonly observed position, they intermittently crawled to her breast to nurse, grasping her long pelage with hands and feet, retaining a tenacious hold.

In less than a week after birth, the young

were more active, seeking various clinging positions upon the mother, and within ten days we were disturbed at their restless crawling, as we had already observed one clinging to the father. Seeing this, I was inclined to remove the male, figuring that this wandering from one parent to another would interfere with the infant animals receiving regular and sufficient nourishment. Watching them closely, however, it was noted that the father transferred them from the mother at regular intervals. This developed into a systematic process, whereby the father took them from the female after short periods of nursing.

The practice was regularly established within two or three days and from this period the father took over entire care of the young, carrying them at all times, even during the night, except when they were nursing. The young appeared to comprehend the process of transference. At approximate periods of two to two and one-half hours, the parents, otherwise nimbly leaping about the cage, would settle together. The female would raise her arms and the male push and shove at the infants, until they had crawled upon the mother, when they immediately started nursing. If they were hesitant about the transfer, the male would bend downward and nip them with enough vigor to induce squeaks of protest, but the disciplinary measure was, as a rule, immediately effective. Nursing periods were approximately a quarter of an hour, when the transference process was reversed. During the periods the male was carrying the young marmosets, the mother paid no attention to them.

When six weeks old, the twins had greatly increased in size, and their pelage was markedly longer, thicker and of darker hue. Their inclination now was to climb upon the father's back, from which position they took a lively interest in what was going on about them. As they grew heavier, the father was literally borne down with his burden, and grew noticeably thinner from the task he had assumed. The burden had greatly decreased his opportunity for exercise and frequent picking over food to obtain variety, which is a marmoset characteristic.

About two months after birth, one of the young could be observed for a moment, sitting beside the father, but upon the least disturbance would hop upon his back. Transfer to the female, at regular nursing periods, continued. Day by day, inclination developed for the twins to leave the father for longer periods, but to remain close by and leap upon him at the slightest disturbance. He was not well rid of carrying them greater part of the time until they were close to four months old, and even after that time there were periods of hours when they would roost upon his back, grasping his long hair with tightly clenched hands. The inclination of the male was to savagely rush at strangers who too closely approached the cage. The mother evinced no such disposition.

When the young were three months old, we observed the male squeezing bits of a banana through his fingers and permitting the offspring to nibble at the soft fruit. Soon after this, as he visited the feeding trays, the clinging young would bend downward for experimental nips. That task of thus introducing them to solid food fell entirely upon the male, and was conducted with what appeared to be systematic care.

At a full five months of age, the young were half grown and leaping as nimbly about the large cage as their parents. Paternal solicitude was undiminished, however, as indicated by the changed feeding habits of the adults. Before the appearance of the young, both marmosets had leaped to the cage front upon the presentation of such favorite food as large grasshoppers and lizards of the *Anolis* type. Food was grasped in selfish spirit, often to the accompaniment of noisy squabbling. It was as quickly and greedily devoured. As the young began feeding upon practically all items consumed by the parents, the feeding habits of the female remained the same. She would greedily rush to the cage front, seize and immediately devour all special foods to be offered. The feeding habits of the male, however, were greatly modified. He would also rush for insect food, decapitate a grasshopper, then hold it until it had been taken by one of the young. This continued until both young had received their share. Any interference with such actions by the female, was savagely resented.

Eight months after birth, the young marmosets are three-quarters grown and their pelage as long and silky as that of their parents. From the rate of growth, it would appear that this species attains adult size in about a year's time.

GENERAL INFORMATION

Membership: Membership is available to all persons who are interested in the work of the Society and wish to lend financial aid toward its support, and cooperate in the future development of the Zoological Park and the Aquarium.

Classes: General membership in the Society is $10.00, payable annually; by payment of $200 anyone can become a Life Member; a contributor of $1,000 becomes a Patron; $2,500 an Associate Founder; $5,000 a Founder; $10,000 a Founder in Perpetuity, and $25,000 a Benefactor.

Benefits of Membership: All classes of members of the Society are entitled to receive every publication, the privileges of the Administration Building, lectures, open meetings, entertainments, exhibitions and free admission to the Aquarium and the Zoological Park every day throughout the year. Complimentary coupon ticket books are issued to each member for use at the Park on the two days of each week when admission is charged, and which were set aside primarily for the benefit of the members and their friends so that the collections might be seen to the best advantage.

Application Forms: Information concerning membership can be obtained at the Aquarium or the Zoological Park, where application forms will be furnished on request. Signed applications for membership may be given to the Director of the Zoological Park, the Director of the Aquarium or mailed directly to the Secretary, William White Niles, 101 Park Avenue, New York City, for action by the Executive Committee.

Zoological Park: The Park is open every day in the year from 10 o'clock in the morning until one-half hour before sunset; admission to the Park is free every day except on Mondays and Thursdays when an admission fee is charged. All holidays are free.

New York Aquarium: The Aquarium is open every day, April 1 to September 30, from 9 o'clock in the morning until 5 o'clock in the afternoon; and October 1 to March 31, from 9 o'clock in the morning until 4 o'clock in the afternoon. No admission is charged.

PUBLICATIONS

Annual Report: Documents and reports of the various departments. Early editions contain articles of scientific value. Illustrated.

Zoologica: Scientific contributions of the New York Zoological Society. Volumes I, II, III, IV, V, VI, and VIII completed. Other volumes in preparation. Issued as subjects are presented. Illustrated.

Zoopathologica: Scientific contributions of the New York Zoological Society on the diseases of animals. Volume I completed. Volume II in preparation. Issued as subjects are presented. Illustrated.

Bulletin: Official publication of the New York Zoological Society, devoted to the work of the Park and the Aquarium. Popular natural history profusely illustrated. Thirty-five volumes completed. Volume XXXVI in preparation. Issued bi-monthly.

Heads and Horns Brochure: Devoted to the Collections of the Heads and Horns Museum. Nos. 1 and 2 completed. Illustrated. Temporarily discontinued.

Guide Book: Official guide to the Zoological Park Collections (Hornaday). Profusely illustrated. Twenty-three editions issued. Published as needed.

Animals: Art Stamps; 32 pp. 120 color stamp ills.
Child's Book: Wild Animals; 96 pp. 50 color ills.
Post-cards: 63 subjects in colors.
Panorama: Bird's-eye View, Zoological Park.
Photogravures, Enlargements, etc.
Pets and How to Care for Them (Crandall); 303 pp. 59 ills.
Present Day Mammals (Leister); 74 pp. 105 ills.
Field Book of Shore Fishes of Bermuda (Beebe-Tee-Van); 337 pp. 343 ills.
Galapagos: World's End (Beebe); 444 pp. 107 ills., 24 in colors.
The Arcturus Adventure (Beebe); 449 pp. 77 ills.
Tropical Wild Life (Beebe; Hartley; Howes); 504 pp. 143 ills.

Aquarium Publications

Guide Book: Official guide to the Aquarium Collections (Townsend). Profusely illustrated. Three editions issued. Published as needed.
Sea Shore Life (Mayer). *Out of print.*
Cultivation of Fishes (Townsend); 27 pp. 17 ills.
Northern Elephant Seal (Townsend). *Out of print.*
Porpoise in Captivity (Townsend); 11 pp. 14 ills.
Whale Shark (Gudger). *Out of print.*
Gaff-topsail Catfish (Gudger). *Out of print.*
Galapagos Tortoises (Townsend); 82 pp. 45 ills.
Locomotion of Fishes (Breder); 138 pp. 45 ills.
Marine Fishes (Nichols-Breder); 192 pp. 263 ills.
Fishes in the Home (Mellen); 178 pp. 63 ills.
The Public Aquarium (Townsend); 97 pp. 47 ills.
Color Changes of Fishes (Townsend); 58 pp. 11 text figs. and 27 color plates.
The Fur Seal of the California Islands (Townsend); 8 pp. 1 color plate, 11 text figs.
Growth and Age in the Giant Tortoise of the Galapagos (Townsend); 8 pp. 13 text figs.

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